GEOLOGICAL SURVEY BRANCH
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

GEOLOGY OF THE ALEXIS RIVER REGION, GRENVILLE PROVINCE, SOUTHEASTERN LABRADOR

T. van Nostrand

Report 92-3

St. John's, Newfoundland
1992

COVER

Flat-lying, caribou-moss-coated plains and small sporadic hills, typical of well-exposed, burned-over areas (ca. 20 years old) in the eastern part of the Alexis River region. The area in the photo is underlain by orthogneiss and foliated granitoid rocks of the Gilbert River belt.

100-05748/

GEOLOGICAL SURVEY BRANCH
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

GEOLOGY OF THE ALEXIS RIVER REGION, GRENVILLE PROVINCE, SOUTHEASTERN LABRADOR

T. van Nostrand

Report 92-3

St. John's, Newfoundland
1992

EDITING, LAYOUT AND DRAFTING

Senior Geologist R.F. BLACKWOOD

Editor C.P.G. PEREIRA

Copy Editor D.G. WALSH

Typesetting B. STRICKLAND

Word Processing D. DOWNEY
J. MATTHEWS

Supervisor, Cartographic and Photomechanical Services K. BYRNE

Cartography D. LEONARD (photomechanical)
T. PALTANAVAGE
T. SEARS

Publications of the Geological Survey Branch are available through the Publications and Information Section, Geological Survey Branch, Department of Mines and Energy, P.O. Box 8700, St. John's, Newfoundland, Canada, A1B 4J6.
Telephone: (709) 729-3159
Telex: 016-4724
Fax: (709) 729-3493

This project is a contribution to the Canada–Newfoundland Cooperation Agreement on Mineral Development, 1990-1994. Project carried out by the Newfoundland Department of Mines and Energy.

ISBN 0-920769-53-5

Authors's Address: *T. van Nostrand*
Labrador Mapping Section
Geological Survey Branch
Department of Mines and Energy
P.O. Box 8700
St. John's, Newfoundland
Canada
A1B 4J6

CONTENTS

Page

ABSTRACT ix

INTRODUCTION 1
LOCATION AND ACCESS 1
PREVIOUS WORK 1
PRESENT INVESTIGATION 2
STRATIGRAPHIC NOMENCLATURE 2
GEOCHRONOLOGY 2
PHYSIOGRAPHY AND EXPOSURE 2

REGIONAL SETTING 3

ROCK UNITS 3
DESCRIPTION OF UNITS 3
Orthogneiss (Unit 1) 3
Granitic Gneiss (Subunit 1g) 3
Granodioritic Gneiss (Subunit 1b) 5
Amphibolitic–Dioritic Gneiss (Subunits 1d/1a) 6
K-feldspar Megacrystic Granite Gneiss (Subunit 1p) 6
Monzonitic Gneiss (Subunit 1m) 6
Paragneiss (Unit 2) 7
Sillimanite-bearing Pelitic Gneiss (Subunit 2s) 7
Psammitic Gneiss (Subunit 2w) 8
Diatexite (Subunit 2x) 9
Muscovite-bearing Gneiss (Subunit 2u) 9
Calc-silicate Gneiss (Subunit 2c) 9
Amphibolite (Subunit 2a) 9
Granitoid Rocks (Unit 4) 9
K-feldspar Megacrystic Granite to Granodiorite (Subunit 4p) 9
Foliated Granite (Subunit 4g) 10
Foliated Granodiorite (Subunit 4b) 11
Foliated Diorite to Quartz Diorite (Subunit 4d) 11
Syenite to Quartz Syenite (Subunit 4h) 12
Foliated Monzonite (Subunit 4m) 12
Muscovite-bearing Granite (Subunit 4u) 12
Amphibolite (Subunit 4a) 12
Upper Paradise River Pluton (Unit 5) 13
Foliated Monzonite (Subunit 5m) 13
K-feldspar Megacrystic Monzonite (Subunit 5mp) 13
Syenite to Quartz Syenite (Subunit 5y) 13
K-feldspar Megacrystic Syenite (Subunit 5yp) 13
Mafic Dykes (Subunit 5a) 14
Alexis River Anorthosite (Unit 6) 14
Anorthosite to Leucogabbro (Subunits 6n/6l) 14
Leucogabbro (Subunit 6l) 14
Anorthosite (Subunit 6n) 14
Amphibolite (Subunit 6a) 15
Mafic Intrusive Rocks (Unit 7) 15
Metagabbro (Subunit 7r) 15
Leucogabbro to Leuconorite (Subunit 7l) 16
Gabbronorite (Subunit 7f) 16
Amphibolite (Subunit 7a) 16
Pegmatite (Unit 8) 16
Deformed Pegmatites 16
Undeformed Pegmatites 16

Page

Mylonitic and Cataclastic Rocks (Unit 10) 17
Mylonites, Submylonites (Subunit 10m) 17
Cataclastic Rocks, Fault Breccia (Subunit 10c) 17
Post-Grenvillian Rocks (Units 12 and 13) 17
Coarse-grained Gabbro Dykes (Subunit 12g) 17
Quartz Veins (Subunit 12q) 17
Fine-grained Diabase Dykes (Subunit 13) 17

STRUCTURE 18

METAMORPHISM 20
MAFIC ROCKS 20
CORONA TEXTURES 20
GRANITOID ROCKS 20
METASEDIMENTARY GNEISS 22
RETROGRADE ASSEMBLAGES 23
DISCUSSION OF LABRADORIAN AND GRENVILLIAN EFFECTS 23

ECONOMIC GEOLOGY 24

SUMMARY 25

ACKNOWLEDGMENTS 25

REFERENCES 26

FIGURES

Page

Figure 1: Regional subdivision of the Grenville Province in eastern Labrador, and location of the study area 1

Figure 2: Location of previously mapped (1:100 000 scale) adjacent map regions in southeastern Labrador 1

Figure 3: Main physiographic features of the Alexis River map region 2

Figure 4: Schematic geological map of the Alexis River map region 4

Figure 5: Location of photographic plates referred to in text 5

Figure 6: Major structures and subdivision in the Alexis River map region 18

Figure 7: Schematic 3-D interpretation of regional structure of the Alexis River anorthosite. Interpretation includes data from the present study area and from the Port Hope Simpson region (Gower *et al.*, 1987) and the Paradise River region (Gower *et al.*, 1985) 18

Figure 8: (a) Distribution of diagnostic mineral assemblages in pelitic gneisses (subunits 2s,c and u); (b) Distribution of diagnostic mineral assemblages in granitoid rocks (Unit 4); (c) Distribution of diagnostic mineral assemblages and textures in gabbroic rocks 22

MAP

Map 92-28: Geology of the Alexis River region, Grenville Province, southeastern Labrador ..... Back pocket

PLATES

Page

Plate 1: Well-banded granite gneiss (subunit 1g), intruded by concordant pegmatite veins (Gilbert River belt)..... 5

Plate 2: Granite gneiss enclaves (subunit 1g) in foliated granite (subunit 4g; Mealy Mountains terrane)..... 5

Plate 3: Banding in granodiorite gneiss (subunit 1b) enhanced by concordant granite veins (Gilbert River belt)..... 6

Plate 4: Granodiorite gneiss enclaves (subunit 1b) in foliated granite (subunit 4g) intruded by late pegmatites (Gilbert River belt)..... 6

Plate 5: Inhomogeneous strain in K-feldspar megacrystic granite (subunits 4p/1p; south of the Alexis River, Mealy Mountains terrane)..... 7

Plate 6: Well-banded, strongly folded sillimanite-bearing metasedimentary gneiss (subunit 2s; Mealy Mountains terrane)..... 7

Plate 7: Strongly attenuated and recrystallized garnets in metasedimentary gneiss (subunit 2s; southwest Pond fault). Matchstick is 4 cm long..... 8

Plate 8: Rotated garnet porphyroblast in metasedimentary gneiss (subunit 2s; implies dextral sense of movement (Southwest Pond fault). Matchstick is 4 cm long..... 8

Plate 9: Well-banded psammitic metasedimentary gneiss (subunit 2w) intruded by concordant and discordant granite veins (South of the Alexis River, Mealy Mountains terrane)..... 9

Plate 10: Amphibolite pod (subunit 2a) in metasedimentary gneiss (subunit 2s; Mealy Mountains terrane)..... 10

Plate 11: 'Pseudo-megacrystic' phase of K-feldspar megacrystic granite (subunit 4p). Note diffuse contacts of K-feldspar megacrysts (Mealy Mountains terrane). Lens cap is 5 cm in diameter..... 10

Plate 12: Recrystallized granite vein truncating fabric in K-feldspar megacrystic granite (subunit 4p; Mealy Mountains terrane)..... 11

Plate 13: Strongly foliated, homogeneous diorite (subunit 4d; Mealy Mountains terrane). Lens cap is 5 cm in diameter..... 11

Plate 14: Large garnet porphyroblasts in foliated diorite (subunit 4d). Note plagioclase + quartz reaction rims around garnets. (Near contact of diorite intrusion, Mealy Mountains terrane.) Lens cap is 5 cm in diameter..... 12

Plate 15: Deformed plagioclase–porphyritic-amphibolite dyke (subunit 4a) in K-feldspar megacrystic granite (subunit 4p; Mealy Mountains terrane)..... 12

Plate 16: Agmatized amphibolite enclave (subunit 4a) in quartz diorite (subunit 4d; Mealy Mountains terrane)..... 13

Plate 17: Weakly foliated to massive K-feldspar megacrystic monzonite (subunit 5mp). K-feldspars locally have recrystallized rims (Mealy Mountains terrane). Lens cap is 5 cm in diameter..... 1

Plate 18: Discordant and concordant amphibolite dykes (subunit 5a) intruding K-feldspar megacrystic alkali-feldspar syenite (subunit 5yp; Upper Paradise River pluton)..... 1

Page

Plate 19: Coarse-grained, recrystallized leucogabbro of the Alexis River anorthosite (subunit 6l; Gilbert River belt)..... 15

Plate 20: Igneous layering in Alexis River anorthosite (subunit 6n). Dark layers consist of hornblende, pyroxene and opaque minerals (Gilbert River belt)..... 15

Plate 21: Discordant amphibolite dykes (subunit 6a) intruding Alexis River anorthosite (subunit 6n; Gilbert River belt)..... 15

Plate 22: Igneous layering preserved in leucogabbro (subunit 7l; Mealy Mountains terrane)..... 16

Plate 23: Fine-grained, post-Grenvillian diabase dyke (Unit 13), intruding foliated quartz diorite (subunit 4d; Upper Paradise River, Mealy Mountains terrane)..... 18

Plate 24: Z-folds in well-banded metasedimentary gneiss (subunit 2s; Mealy Mountains terrane). Pencil is 15 cm long..... 19

Plate 25: Open M-folds in well-banded granite gneiss (subunit 1g). Banding enhanced by concordant granite veins (Gilbert River belt)..... 19

Plate 26: Mylonitic granite (subunits 4g/10m) showing C−S fabric suggesting dextral (east over west movement). Enclave in gabbro of White Bear Arm complex..... 19

Plate 27: Small-scale dextral shear zone in K-feldspar megacrystic granite (subunit 4p; Alexis River, Mealy Mountains terrane). Pencil is 15 cm long..... 19

TABLE

Table 1. Mineral assemblages in granitoid rocks, paragneiss and mafic rocks..... 21

ABSTRACT

The Alexis River map region lies within the Grenville Province, southeastern Labrador, and is divided into three main lithostructural segments. From northeast to southwest, these are: the White Bear Arm complex (part of the Hawke River terrane), the Gilbert River belt (part of the Lake Melville terrane), and the Mealy Mountains terrane.

The White Bear Arm complex consists of gabbro and gabbronorite, having kilometre-scale enclaves of sillimanite-bearing metasedimentary paragneiss, mylonitized granite and K-feldspar megacrystic granite.

The Gilbert River belt is underlain by several narrow, northwest-trending belts of variable (but generally intensely deformed) rocks. These include granite to granodiorite gneiss, sillimanite-bearing migmatitic, pelitic and psammitic paragneiss along with minor calc-silicate gneisses, hornblende-rich, massive to locally migmatitic dioritic to amphibolitic gneiss, K-feldspar megacrystic granodiorite to granite, equigranular granodiorite to granite, and meta-anorthosite.

The Mealy Mountains terrane consists of variably deformed, granodiorite to granite, diorite to quartz diorite, K-feldspar megacrystic granite to alkali-feldspar granite, semipelitic to psammitic paragneiss, and a composite intrusion of syenite to quartz monzonite, which is informally named the Upper Paradise River pluton.

Post-Grenvillian rocks include northeast-trending, coarse-grained gabbro dykes, quartz veins and fine-grained diabase dykes. Regional structural trends in the White Bear Arm complex and the Gilbert River belt are northwest. In the Mealy Mountains terrane, the structural trends vary from northwest in the eastern exposures to northeast in the south. Upper amphibolite metamorphic assemblages characterize most of the region with evidence that granulite-facies conditions were attained locally. Lower amphibolite-facies retrogressive assemblages are developed in most units.

Magnetite crystals associated with mafic rocks, and minor pyrite in post-Grenvillian dykes were the only observed mineralization.

INTRODUCTION

LOCATION AND ACCESS

The Alexis River map area is located in the Grenville Province, southeastern Labrador (Figure 1). It covers an area of approximately 3800 km² and includes NTS map sheets 13A/11, 12, 13 and 14. Access to the area is best attained by chartered aircraft from Goose Bay or from communities along the coast of southern Labrador. A gravel road from the community of Port Hope Simpson, extends approximately 15 km east of the map region. The region lies immediately south of the Paradise River map region (Gower *et al.*, 1985) and to the west of the Port Hope Simpson map region (Gower *et al.*, 1987).

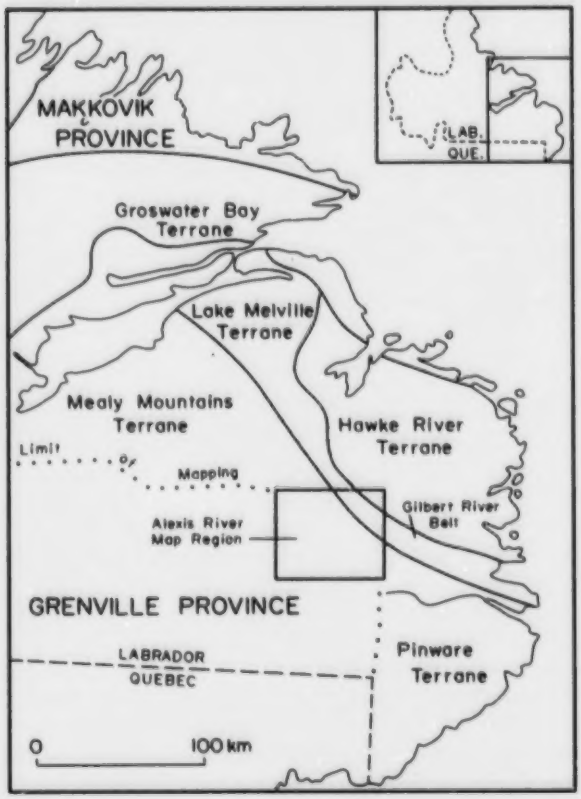


Figure 1. *Regional subdivision of the Grenville Province in eastern Labrador, and location of the study area.*

PREVIOUS WORK

Previous work in the Alexis River region was included in a 1:500 000 reconnaissance-scale map by Eade (1962). Unpublished data for 30 stations were obtained by C.F. Gower in 1987.

Eade (1962) describes the area as being underlain by predominantly granitic gneiss in the east and monzonitic to granodioritic rocks in the west. Three thin sections examined from Eade's study were: a quartz + K-feldspar + plagioclase + sillimanite + biotite + garnet + muscovite metasedimentary pelitic gneiss, an orthopyroxene-bearing syenitic rock from the northwestern part of the region and a hornblende-bearing quartz syenite from the central part of the region.

The results of mapping by Eade (1962) within the area were later used by Greene (1972) in a geological compilation map of Labrador, and also in a general descriptive account of Labrador geology (Greene, 1974).

Regions to the north, northeast, east and southeast of the Alexis River region have been mapped at 1:100 000 scale by Gower *et al.* (1985, 1986b, 1987 and 1988a; Figure 2). Aeromagnetic map coverage at 1:250 000 and 1:63 360 scale is available for the region (Geological Survey of Canada, 1974a, b). A 1:250 000-scale, colour-shaded relief aeromagnetic map is also available for the region (G. Kilfoil, unpublished data).

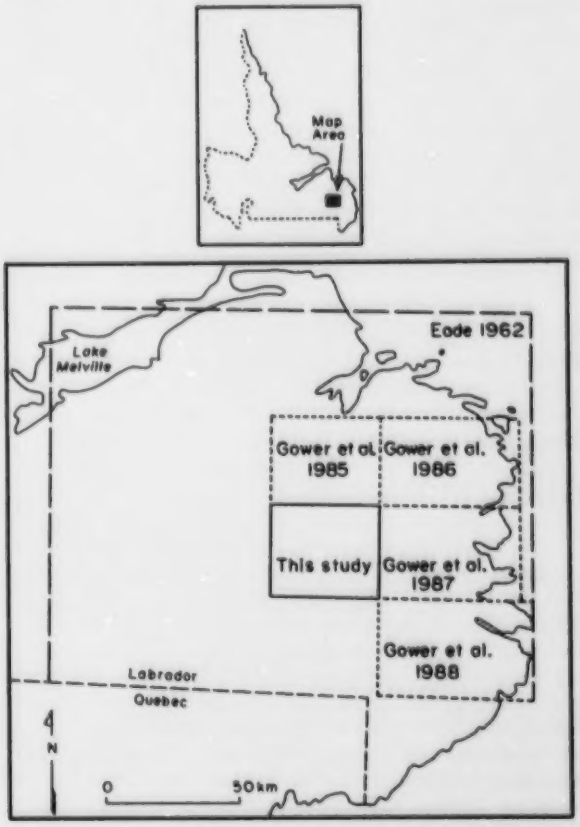


Figure 2. *Location of previously mapped (1:100 000 scale) adjacent map regions in southeastern Labrador.*

PRESENT INVESTIGATION

The objectives of the Alexis River mapping project were to continue the 1:100 000-scale mapping of the Grenville Province in eastern Labrador, to further define the major terrane boundaries and units previously mapped to the north and east of the area by Gower *et al.* (1986a, 1988b) and to assess the current economic mineral potential of the region. Field mapping was carried out from June to August, 1992.

STRATIGRAPHIC NOMENCLATURE

Gower *et al.*, (1988a) proposed the term Southwest Pond domain for an area of metasedimentary gneiss and K-feldspar megacrystic granitoid rocks in the northwest corner of the St. Lewis River map region. At the time, inclusion of this area in the Mealy Mountains terrane was withheld pending further mapping. Subsequent mapping in the Alexis River region has shown that the Southwest Pond domain is part of the Mealy Mountains terrane, and it is recommended that the name Southwest Pond domain be abandoned (C.F. Gower, personal communication, 1991).

The Gilbert River shear belt was used by Gower *et al.* (1987) (Figure 2) to describe the eastern extension of the Lake Melville terrane in the Port Hope Simpson map region. Investigations by Hanmer and Scott (1990), along a coastal section of the terrane, concluded that the proportion of highly strained rocks within the coastal section is small and they preferred the name the Gilbert River belt to describe the zone. In the Alexis River region, most of the units within the belt are highly strained, although in the northwestern part of the belt, deformation is generally only moderate and zones of intense strain are localized. Thus the name, the Gilbert River belt, will be used throughout this report to describe the extension of the Lake Melville terrane from the Port Hope Simpson map region.

Gower *et al.* (1987) assigned the Alexis River anorthosite for a zone of anorthositic to gabbronoritic rocks in the Port Hope Simpson map region. Gower *et al.* (1985) described a zone of unnamed anorthositic rocks in the Paradise River map region, which was subsequently included as part of the Alexis River anorthosite (Gower *et al.*, 1987).

GEOCHRONOLOGY

Geochronological data are not available from the region, but extrapolation from dated units in the Paradise River and Port Hope Simpson map regions (Gower *et al.*, 1985, 1987) (Figure 2) to the north and east, suggests that most of the rock units in the study area have ages between 1680 and 1630 Ma. In the extreme northwestern part of the area, an extension of a syenitic to monzonitic unit in the Paradise River region was dated at 1631 ± 1 Ma (U–Pb on monazite; Schärer *et al.*, 1986) and 980 ± 3 Ma ($^{40}Ar/^{39}Ar$ on hornblende; van Nostrand, 1988).

PHYSIOGRAPHY AND EXPOSURE

Much of map region is characterized by an undulating topography having an average elevation of approximately 300 m above sea level. The highest elevation of 525 m occurs in the southwest, whereas the area southeast of the Alexis River marks the lowest elevations at 180 m.

Topographic features in some areas correlate with distribution of rock types. Gabbroic rocks, particularly in the White Bear Arm complex, form hills having average elevations of 420 m. Foliated granites and orthogniess generally occur in low-lying areas and valleys. Metasedimentary gneiss usually occurs as steep, undulating hills, particularly in the southeast corner.

The drainage pattern in much of the region shows a northwest preferred orientation, reflecting the dominant northwest-trending regional bedrock geology in the Gilbert River belt and the northeast portion of the Mealy Mountains terrane. Northwest-trending rivers define strong lineaments and in some cases unit boundaries, in particular adjacent to the Gilbert River fault. In the southeast and northwest parts of the region, the drainage pattern is northeasterly, controlled by the Paradise and Alexis rivers (Figure 3).

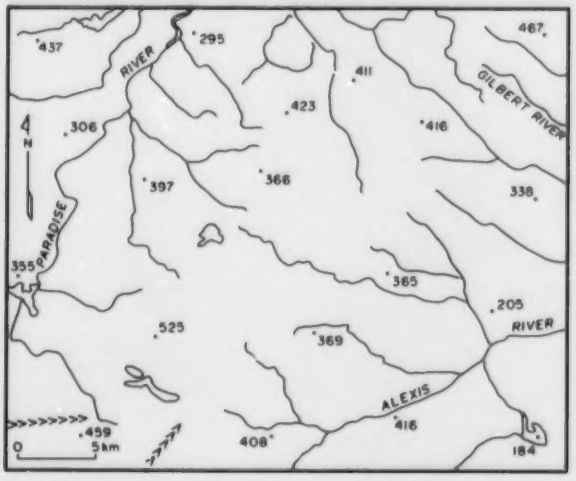


Figure 3. *Main physiographic features of the Alexis River map region.*

Much of the western and northern parts of the map area is covered by extensive glaciofluvial deposits including sand plains, dunes and eskers.

In the western and northern parts of the region, outcrops are limited to flat exposures in sand plains, to small exposed hills and to exposures in rivers. The central area is dominated by low-lying string bogs and woods, and exposure is present on hills and in stream beds.

The eastern part of the region is well exposed in old burned-over areas (*ca.* 20 years) and along rivers, particularly along the Alexis River, after which the region is named.

REGIONAL SETTING

The Grenville Province in eastern Labrador is divided into five distinct lithostructural terranes (Gower, 1990; Gower *et al.*, 1987, 1988a). From north to south, these include: (i) Groswater Bay terrane, (ii) Lake Melville terrane, (iii) Mealy Mountains terrane, (iv) Hawke River terrane, and (v) Pinware terrane (Figure 1).

Three of these terranes transect the Alexis River region: (i) Hawke River terrane, which includes the White Bear Arm complex, (ii) Lake Melville terrane including the Gilbert River belt and (iii) Mealy Mountains terrane.

The Hawke River terrane consists of diorite to quartz monzonite, pelitic metasedimentary gneiss, including the Paradise Metasedimentary Gneiss Belt (Gower *et al.*, 1986b), monzonite and granite plutons, and a large gabbronorite intrusion termed the White Bear Arm complex (Gower *et al.*, 1987). A segment of the White Bear Arm complex underlies the northeast corner of the Alexis River region.

The Lake Melville terrane, consists of granodioritic and metasedimentary gneiss, associated K-feldspar megacrystic granitoid rocks, granodiorite, monzonite and syenite plutons and mafic intrusions. The Gilbert River belt (Hanmer and Scott, 1990) is the eastern extension of the terrane, and, in the Alexis River region, these rock types are cut by strongly deformed, northwest-trending zones.

The western part of the Mealy Mountains terrane is dominated by anorthositic to monzonitic rocks of the Mealy Mountains Intrusive Suite (Emslie, 1976). In the east, which includes a large part of the Alexis River region, the terrane consists of granite to granodioritic gneiss, sillimanite-bearing metasedimentary gneiss, foliated K-feldspar megacrystic and non-megacrystic granite to granodiorite and syenite to quartz monzonite.

Schärer and Gower (1988) proposed a regional kinematic synthesis of the Grenville Province in eastern Labrador based on structural analyses and radiometric ages. They suggested that the Mealy Mountains and Hawke River terranes are structurally the highest. The Hawke River terrane was thrust onto the Lake Melville terrane, and the Mealy Mountains terrane was thrust onto the Lake Melville and part of the Groswater Bay terrane. Based on U–Pb ages on monazite and zircon, they proposed that burial of the Lake Melville and Groswater Bay terranes, resulted in Grenvillian overprints at 1040 to 1030 Ma and 980 to 968 Ma, respectively (C.F. Gower, personal communication, 1992). In contrast, the structurally higher Hawke River and Mealy Mountains terranes experienced only localized Grenvillian metamorphic effects along terrane boundaries.

ROCK UNITS

Lithological units within the Alexis River region are distinguished on the basis of field observations and examination of approximately 500 rock slabs, stained specifically for K-feldspar. In addition, petrographic studies were carried out on approximately 275 thin sections prepared from selected samples. Division of granitoid and orthogneiss units follows the classification of Streckheisen (1976). Metasedimentary gneiss units are distinguished on the basis of the mineral assemblages and composition and mafic rocks are subdivided on the basis of texture and composition. A schematic geological map of the region is shown in Figure 4 and a 1:100 000-scale geological map (Map 92-28) also accompanies this report. (For Units and subunits not seen on Figure 4, refer to Map 92-28.) Location of plates referred to in the text are shown in Figure 5.

Unit numbers were established in a composite regional legend used by Gower *et al.* (1986a, 1988b). Units 3, 9 and 11 are not present in the Alexis River region. Unit 3 is reserved mainly for granitoid rocks associated with the Earl Island domain to the north of the study area (Gower *et al.*, 1985). Unit 9 designates minor, metamorphosed and deformed mafic dykes, and Unit 11 designates granitoid rocks of late- to post-Grenvillian age (see accompanying notes on map).

The following section describes units in the Alexis River region in order of abundance and does not necessarily follow the order in which they are presented in the legend.

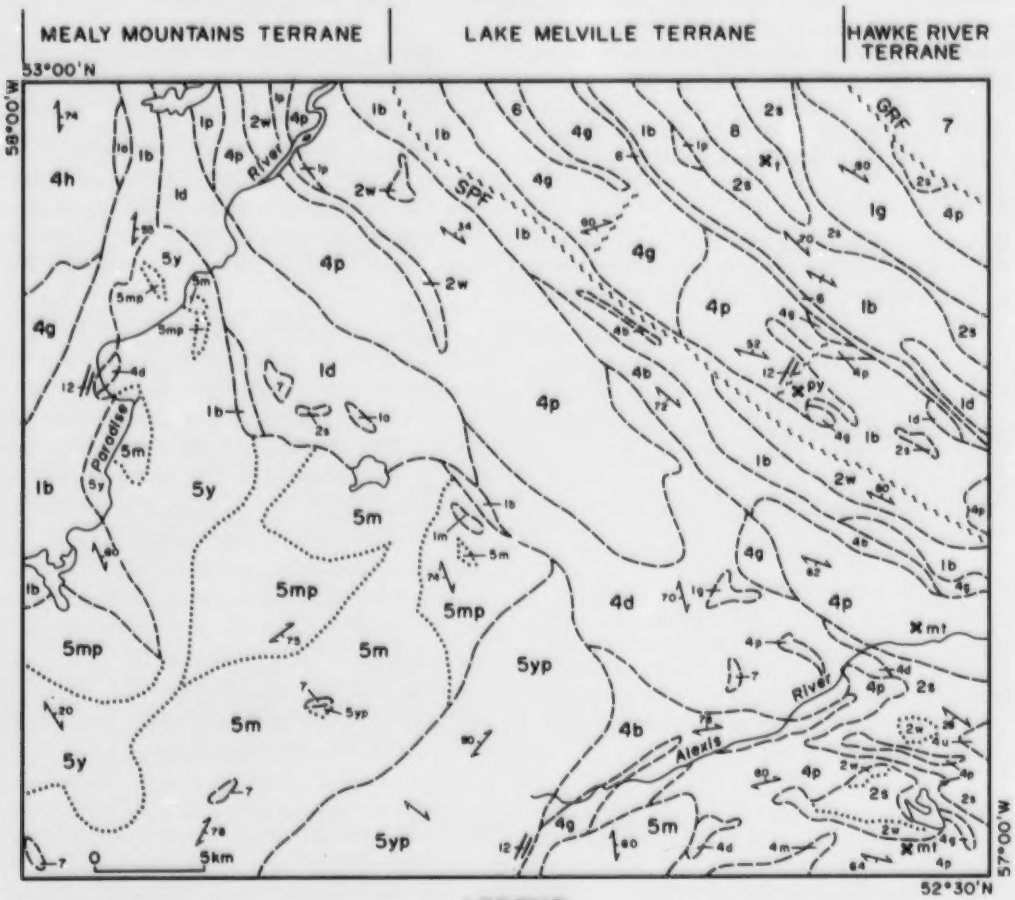
DESCRIPTION OF UNITS

Orthogneiss (Unit 1)

Orthogneiss in the Alexis River region occurs predominantly in the Gilbert River belt as northwest-trending units, and, in the Mealy Mountains terrane, as northwest-trending belts and as enclaves in granitoid intrusive rocks. Orthogneiss rocks are distinguished by a moderately to strongly developed gneissosity, although gradations to foliated equivalents occur in several localities.

Granitic Gneiss (Subunit 1g)

Granitic gneiss occurs in the Gilbert River belt in a northwest-trending, 5- to 8-km-wide belt in the northeast corner of the region and as isolated zones within granodioritic gneiss (subunit 1b) farther south. The granitic gneiss is medium grained, pink-, white-, to red-weathering, and characterized by alternating, cm-scale biotite + hornblende ± garnet-rich bands and quartz + plagioclase + K-feldspar-



LEGEND

LATE PRECAMBRIAN TO EARLY PALEOZOIC

12 *Gabbro, diabase*

MIDDLE TO LATE PROTEROZOIC

8 *Pegmatite*

MAFIC INTRUSIVE ROCKS

7 *Gabbro, gabbronorite*

6 Alexis River anorthosite

GRANITOID ROCKS

Upper Paradise River Pluton

5mp *K-feldspar megacrystic monzonite to quartz monzonite*
5yp *K-feldspar megacrystic alkali-feldspar syenite*
5y *Syenite to quartz syenite*
5m *Monzonite to quartz monzonite*

MIDDLE TO LATE PROTEROZOIC

4p *K-feldspar megacrystic granite to granodiorite*
4g *Granite, alkali-feldspar granite*
4m *Monzonite to quartz monzonite*
4u *Muscovite-rich granite*
4b *Granodiorite*
4h *Hornblende syenite*
4d *Diorite to quartz diorite*

PARAGNEISS

2s *Sillimanite-bearing pelitic metasedimentary gneiss*
2w *Psammitic metasedimentary gneiss*

ORTHOGNEISS

1a *Amphibolite gneiss*
1g *Granite gneiss*
1b *Granodiorite gneiss*
1d *Diorite gneiss*
1m *Monzonite gneiss*
1p *K-feldspar megacrystic granite gneiss*

SYMBOLS

Geological contact (approximate, assumed)
Undifferentiated faults (mostly strike-slip)
Gneissosity, foliation — *Dyke*

×py *Pyrite occurrence,* X_{mt} *(magnetite),* X_t *tourmaline*
GRF *Gilbert River fault*
SPF *Southwest Pond fault*

Figure 4. *Schematic geological map of the Alexis River map region.*

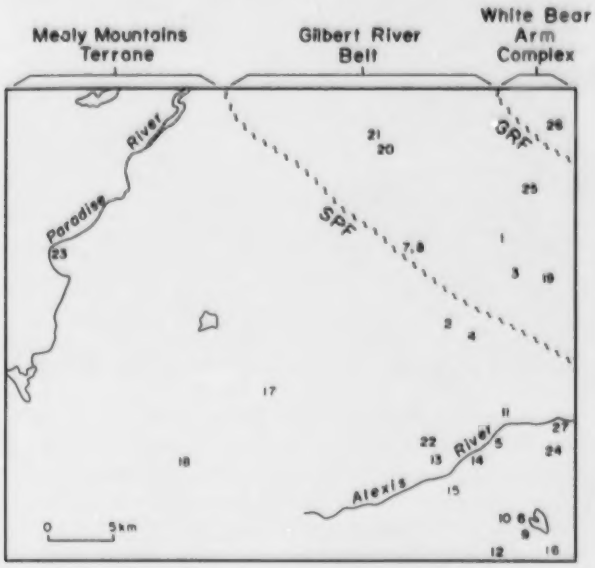


Figure 5. *Location of photographic plates referred to in text.*

rich bands. The banding is typically straight and well defined by sharp boundaries between mafic and leucocratic bands and is commonly enhanced by concordant leucogranitic and/or amphibolitic veins and dykes (Plate 1). In some areas, the banding is tight to isoclinally folded about moderately plunging axes, and is locally transitional into transposed folded bands. At a few localities, cm-scale granitic gneiss enclaves predate foliated granite (subunit 4g). Contacts of the enclaves are diffuse (Plate 2) in some zones suggesting that some degree of assimilation has occurred between the host granite and the gneissic enclaves. In other areas, well-banded granite gneiss is gradational into foliated granite, observed as a 'breakdown' of a well-defined banding into diffusely banded granite to a moderately to strongly foliated, homogeneous granite.

Granodioritic Gneiss (Subunit 1b)

Granodioritic gneiss is a major rock type in the Gilbert River belt and occurs as a northwest-trending belt flanking the Upper Paradise River pluton and as a northwest-trending wedge south of the Southwest Pond fault. It also occurs as enclaves within foliated diorite (subunit 4d) in the southeastern portion of the region.

The rock is white-, pink-, red- and grey-weathering, fine to medium grained, and characterized by a well-developed gneissosity defined by alternating mafic and leucocratic-rich bands. The gneissosity in many areas is enhanced by concordant granitic veins that are truncated by undeformed

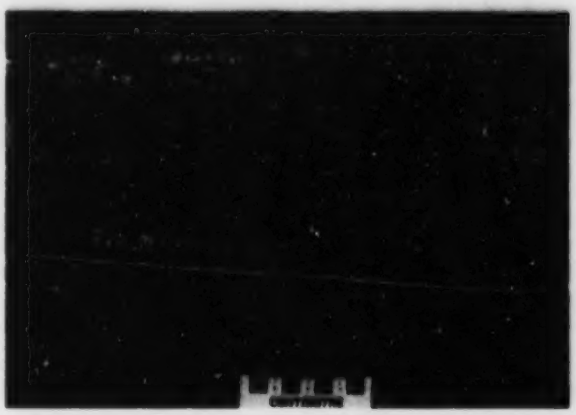


Plate 1. *Well-banded granite gneiss (subunit 1g), intruded by concordant pegmatite veins (Gilbert River belt).*

Plate 2. *Granite gneiss enclaves (subunit 1g) in foliated granite (subunit 4g; Mealy Mountains terrane).*

pegmatites (Plate 3). The mineral assemblage is K-feldspar + plagioclase + quartz + biotite ± hornblende ± garnet + opaque ± zircon ± sphene.

In the Gilbert River belt, granodiorite gneiss underlies two northwest-trending belts. Both are extensions of units mapped in the Paradise River and Port Hope Simpson regions to the north and east (Gower *et al.*, 1986a, 1988b).

A northwest-trending belt of granodiorite gneiss is shown on the accompanying map (Map 92-28) as underlying the southern boundary of the Gilbert River belt in the east and as underlying the northern margin of the Mealy Mountains terrane in the west of the region. Extrapolation of the unit across the region is based largely on a continuous positive areomagnetic signature, as exposure along the inferred fault is poor. The distribution of the same granodiorite gneiss unit across the boundary of the two terranes suggests that the fault may represent only a small lateral movement or that deformation along the fault is contained by, and resulted in, development of the fabric in the granodiorite gneiss unit.

Plate 3. *Banding in granodiorite gneiss (subunit 1b) enhanced by concordant granite veins (Gilbert River belt).*

The granodiorite gneiss contains abundant enclaves or intrusions of K-feldspar megacrystic granite (subunit 4p), dioritic gneiss (subunit 1d) metasedimentary gneiss (subunit 2s), and foliated granite (subunit 4g).

Granodiorite gneiss enclaves are common in foliated granite bodies in the southeastern part of the area. The contacts with the granite are sharply defined and intruded by late granite pegmatite veins in a few areas (Plate 4).

Plate 4. *Granodiorite gneiss enclaves (subunit 1b) in foliated granite (subunit 4g) intruded by late pegmatites (Gilbert River belt).*

In the western part of the Mealy Mountains terrane, a north-trending belt of granodiorite gneiss occurs as elongate zones flanking the western and eastern margins of the Upper Paradise River pluton. The fabric in the gneiss is concordant with the margins of the pluton and implies that the configuration of the gneiss may be a result of intrusion of the pluton. Similar north-trending intrusions or enclaves of foliated diorite and amphibolitic gneiss are present within the granodiorite gneiss, along the western edge of the Upper Paradise River pluton.

Amphibolitic – Dioritic Gneiss (Subunit 1d/1a)

Amphibolitic to dioritic gneiss occurs as a large northwest-trending unit in the western part of the Mealy Mountains terrane, as enclaves within granitoid rocks and orthogneiss and associated with the Alexis River anorthosite in the Gilbert River belt.

In the western part of the Mealy Mountains terrane, dioritic to amphibolitic gneiss occurs as a northwest-trending belt flanking the northeast margin of the Upper Paradise River pluton. Exposure is poor in this area and much of the unit is extrapolated from positive aeromagnetic signatures (G. Kilfoil, 1991; Geological Survey of Canada, 1974b). The rocks are black- to grey-weathering, and medium grained, exhibiting a well to poorly defined banding, which is locally enhanced by concordant plagioclase-rich veins.

Dioritic gneiss associated with the Alexis River anorthosite in the Gilbert River belt occur as less than 1-km-wide zones in the eastern part of the region. The rock is black- to grey-weathering, fine to medium grained, and ranges from strongly foliated to gneissic. The mineral assemblage includes plagioclase + quartz + hornblende + biotite and an opaque phase. Gower *et al.* (1987) noted similar associations in the Port Hope Simpson region, and suggested that the gneisses are metamorphic derivatives of anorthosite-related rocks.

K-feldspar Megacrystic Granite Gneiss (Subunit 1p)

K-feldspar megacrystic granite gneiss is a minor unit and occurs in mappable areas in the northwest and northeast of the region, and also as outcrop-scale gradations from foliated K-feldspar megacrystic granite throughout the region. The rock is pink- to white- to red-weathering and medium to coarse grained. A strong augen gneiss fabric is defined by strongly attenuated and recrystallized K-feldspar megacrysts, wrapped by mm- to cm-wide bands of quartz + plagioclase + K-feldspar + biotite ± hornblende ± garnet and an opaque phase. In the northwest part of the region, a wedge of K-feldspar megacrystic granite gneiss forms a strongly deformed contact phase of a large foliated K-feldspar megacrystic granite intrusion. Outcrop-scale gradations from foliated to gneissic K-feldspar megacrystic granite occur in several localities. Complete gradations occur over tens of metres in some areas and in some outcrops more abrupt gradations from weakly foliated to gneissic granite are partially controlled by cm-scale shear zones (Plate 5). These shear zones are common in the granitoid rocks. Variable gneissosity trends, enveloping moderately deformed zones in some outcrops, attest to a highly variable strain gradient on very local scales.

Monzonitic Gneiss (Subunit 1m)

Two localized zones of monzonitic gneiss occur within the Upper Paradise River pluton. The rocks are rusty brown-weathering, medium grained, well banded and characterized by a deeply weathered texture. The mineral assemblage is

Plate 5. *Inhomogeneous strain in K-feldspar megacrystic granite (subunits 4p/lp; south of the Alexis River, Mealy Mountains terrane).*

plagioclase + K-feldspar + quartz + biotite + hornblende ± garnet and an opaque phase. Contacts with the surrounding moderately to strongly foliated monzonitic rock were not observed at either locality. However, similarity in composition and weathered texture suggests the gneisses are gradations from the monzonite.

Paragneiss (Unit 2)

Paragneiss occurs in all three of the lithostructural divisions of the Alexis River region. In the White Bear Arm complex, the rocks are present as km-scale enclaves within gabbro and gabbronorite. In the Gilbert River belt the gneiss occurs as northwest-trending belts and enclaves within other units. Metasedimentary gneiss in the Mealy Mountains terrane is closely associated with K-feldspar megacrystic granite and granodiorite, occurring as irregularly shaped bodies interfingering with the granitoid rocks. Most of the metasedimentary gneiss in the region is grouped into one of two compositional units; subunit 2s (sillimanite-bearing pelitic gneiss) and 2w (psammitic gneiss). Minor units of muscovite-rich gneiss (subunit 2u), calc-silicate rocks (subunit 2c), cordierite-bearing gneiss (subunit 2z) and amphibolite (subunit 2a) also occur, usually as metre- and cm-scale intercalations within subunits 2s and 2w.

Sillimanite-bearing Pelitic Gneiss (Subunit 2s)

Sillimanite-bearing pelitic gneiss is relatively homogeneous throughout the region, although variations within individual outcrops occur. The gneiss is white-, to pink- to grey-weathering, medium to coarse grained, schlieric to layer textured, and characterized by the presence of sillimanite, having a well-defined, mm- to cm-scale melanosome and leucosome. The melanosome is composed of sillimanite + biotite + an opaque phase ± garnet ± muscovite. Rare cordierite and orthopyroxene were observed separately in only two localities within the Mealy Mountains terrane (see metamorphism section). The leucosome component is comprised of quartz + K-feldspar + plagioclase + minor amounts of sillimanite, biotite and opaque minerals. Banding is typically complexly folded and transposed, and in many areas is enhanced by concordant leucogranite veins. Garnet is a near-ubiquitous phase in these rocks, particularly in the southeast corner of the Mealy Mountains terrane, where the metasediments are closely associated with K-feldspar megacrystic granitoid rocks.

In the White Bear Arm complex, sillimanite-bearing metasedimentary gneiss occurs as a km-scale enclave within metagabbro (subunit 7r). The gneiss is well banded, medium grained, and contains sillimanite + biotite + an opaque phase + zircon + allanite + sphene in the melanosome. Associated with this rock is a minor diatexite component (subunit 2x), gradational from the well-banded gneiss.

The diatexite is massive to weakly foliated, medium to coarse grained and contains plagioclase + quartz + K-feldspar + biotite + garnet + sillimanite and an opaque mineral. Sillimanite-bearing paragneiss in the Gilbert River belt occurs as a Y-shaped wedge, which is continuous across the northwest corner of the region and as km- to m-scale enclaves within other units. Two types of paragneiss are present, the first is a pink-, to white- to cream-weathering, schlieric textured to layered migmatite, having complex and variable fold styles (Plate 6). The fabric is defined by an alternating quartz + feldspar-rich leucosome and a biotite + sillimanite + garnet + opaque mineral-rich melanosome. Retrograde muscovite is locally present, and, in most areas, postdates the time of fabric formation. The second type is a white- to rusty-weathering, homogeneous diatexite that occurs as gradations from the well-layered gneiss described above. Garnet, biotite, and opaque mineral assemblages are present as mm- to cm-wide melanosome layers. Rare sillimanite is present near contacts with sillimanite-bearing pelitic gneiss. Quartz, plagioclase, K-feldspar and minor biotite, garnet and opaque minerals comprise the leucosome.

Plate 6. *Well-banded, strongly folded sillimanite-bearing metasedimentary gneiss (subunit 2s; Mealy Mountains terrane).*

Along the Southwest Pond fault, metasedimentary gneiss outcrops as a quartz + plagioclase + K-feldspar + muscovite + biotite schist to gneiss in the east and a quartz + plagioclase + K-feldspar + biotite + garnet + sillimanite gneiss in the northwest. The schist is grey-weathering, medium grained, strongly foliated and tightly folded. The schistose fabric is defined by finely alternating biotite-rich and quartz + plagioclase + K-feldspar-rich layers. Subhedral muscovite (up to 20 percent) books postdate the main biotite fabric.

The gneiss in the northwestern portion of the fault is white- to grey-weathering, medium grained, strongly recrystallized and highly strained. The gneissosity is a straight, submylonitic fabric defined by attenuated, recrystallized garnets, alternating biotite + sillimanite-rich layers and quartz + K-feldspar + plagioclase-rich layers (Plate 7). The degree of strain is accentuated by large, dextrally rotated garnets up to 4 cm in diameter (Plate 8). The different regimes along the fault suggest that different structural levels of the fault are exposed. The more ductile regime in the northwest may represent a deeper level of the fault, whereas the more brittle textures in the east suggest a high level deformation. Alternatively, the eastern, more brittle, zone could conceivably be a later reactivation of an earlier deep-level fault.

Plate 7. *Strongly attenuated and recrystallized garnets in metasedimentary gneiss (subunit 2s; Southwest Pond fault). Matchstick is 4 cm long.*

In the Mealy Mountains terrane, sillimanite-bearing pelitic gneiss occurs in the southeast corner of the region and in two small enclaves in the northwestern area. In the southeast corner, the gneiss is interlayered with K-feldspar megacrystic granite to granodiorite (subunit 4p). The gneiss is white- to pink- to grey-weathering, medium to coarse grained and characterized by schlieric to layered migmatitic textures. The mineral assemblage consists of a K-feldspar + plagioclase + quartz leucosome and sillimanite + biotite ± garnet ± muscovite and an opaque phase in the melanosome. Sillimanite is widespread and in many areas occurs as aggregates in layers up to 2 cm wide. Garnet is a near-ubiquitous phase and occurs as euhedral porphyroblasts up to 3 cm in diameter.

Plate 8. *Rotated garnet porphyroblast in metasedimentary gneiss (subunit 2s; implies dextral sense of movement (Southwest Pond fault). Matchstick is 4 cm long.*

In the northwestern area of the Mealy Mountains terrane, a small zone of pelitic gneiss within a belt of psammitic gneiss contains sillimanite + garnet + cordierite + biotite + an opaque phase in the melanosome and quartz + plagioclase + K-feldspar in the leucosome. The presence of cordierite is a diagnostic feature of pelitic gneiss to the north of the study area in the Paradise metasedimentary gneiss belt in the Hawke River terrane (Gower *et al.*, 1986b, 1987). However, it is rare in the Mealy Mountains terrane (except as a contact metamorphic mineral marginal to the Mealy Mountains intrusive suite) and only one occurrence has been recognized in the study area (see metamorphism section). The cordierite occurs as 2- to 3-mm-diameter porphyroblasts within the melanosome of a well-banded, migmatitic paragneiss. The cordierite is partially to completely pseudomorphed by numerous inclusions of biotite, sillimanite and quartz. Small (1 to 2 mm in diameter) pinitized grains occur as inclusions in garnet and as isolated fragments, probably xenocrysts, in the leucosome. Metamorphic reactions are discussed in the metamorphism section.

South of this locality, an enclave of migmatitic pelitic gneiss within dioritic gneiss (subunit ld) contains a granulite-facies assemblage containing sillimanite + orthopyroxene + biotite. The orthopyroxene is present as small (0.2 mm) anhedral grains co-existing with sillimanite in the melanosome. The isolated orthopyroxene occurrences suggests a derivation from deeper crustal levels than the more dominant sillimanite + garnet assemblages characteristic of metasedimentary gneiss.

Psammitic Gneiss (Subunit 2w)

Quartzofeldspathic psammitic gneiss occurs as northwest-trending, 2- to 5-km-wide belts in the northeastern part of the Gilbert River belt and as km-scale zones within the pelitic gneiss in the southeast corner of the Mealy Mountains terrane. The psammitic gneiss is also common as cm- to m-scale intercalations and gradations within pelitic gneiss throughout

the mapped region. The psammitic gneiss varies from white-, to grey-, to rusty to pink-weathering, medium to coarse grained, and is well banded. The composition is predominantly arkosic, in which the quartz-rich psammite comprises only a small proportion of the unit. Banding in the rock is defined by a quartz + plagioclase + K-feldspar-rich leucosome and a biotite ± garnet ± sillimanite ± muscovite-rich melanosome. Biotite and garnet are the dominant mafic phases and sillimanite and muscovite occur as a minor phase, particularly near the contact with the more pelitic zones. Biotite, sillimanite and muscovite are also present within the leucosome to varying degrees, which in some cases may be xenocrysts. The scale of banding varies, although the leucosome component is typically tens of centimetre wide with thin (mm- to cm-wide) mafic-rich bands. In many areas, the banding is enhanced by concordant and commonly strongly folded granitic veins (Plate 9).

Plate 9. *Well-banded psammitic metasedimentary gneiss (subunit 2w) intruded by concordant and discordant granite veins (south of the Alexis River, Mealy Mountains terrane).*

Diatexite (Subunit 2x)

A relatively minor supracrustal rock type is diatexite, which is present as outcrop-scale zones within banded psammitic and pelitic gneiss. In many cases, the designation of 'diatexite' is based on association with recognizable metasedimentary gneiss, as it is similar in composition and texture to granitic rocks of Unit 4. The diatexite is white-, to pink- to rusty-weathering, medium to very coarse grained and characterized by a homogeneous, granitic textured quartz + plagioclase + K-feldspar matrix with small selvages and pods of biotite ± garnet ± muscovite ± sillimanite. In some areas, a gradation from well-banded psammite and pelite to diatexite occurs, probably resulting from a remobilization and high degree of melting of the psammitic and pelitic gneiss. Garnet is a ubiquitous phase of the diatexite and occurs as euhedral porphyroblasts up to 4 cm in diameter. Associated with the diatexite, in many areas, is a massive to weakly foliated, fine- to medium-grained, alkali-feldspar granite, characterized by small euhedral pink garnets in a saccharoidal matrix of K-feldspar, quartz and minor plagioclase. The granite is interpreted as a late-stage melt product of the diatexitic rock.

Muscovite-bearing Pelitic Gneiss (Subunit 2u)

Muscovite-bearing metasedimentary gneiss is a relatively minor rock type within the region, occurring as map-scale units and as cm- to m-scale intercalations within sillimanite-bearing pelitic gneiss and psammitic gneiss. Muscovite occurs as a minor secondary phase replacing sillimanite and locally biotite in many areas. However, it typically comprises less than 1 percent of the total rock. Along the Southwest Pond fault, a zone of pelitic gneiss contains up to 20 percent muscovite. The muscovite occurs as large subhedral grains that postdate the main schistosity. The formation of muscovite is probably related to retrogression during faulting.

Calc-Silicate Rocks (Subunit 2c)

Calc-silicate rocks are a very minor unit within the region and are found at two outcrops; (i) within the large granite pegmatite field in the northwestern part of the region adjacent to sillimanite-bearing metasedimentary gneiss, and (ii) associated with psammitic gneiss immediately south of the Southwest Pond fault in the eastern portion of the area. In the northeastern area (52°59′25″ N 57°14′30″ W), the rock is grey- to white-weathering, medium grained, banded and contains light brown (andraditic) garnet, clinopyroxene, muscovite, minor hornblende, quartz and an opaque phase. Layering is defined by alternating, cm-wide, garnet + clinopyroxene + opaque phase-rich and muscovite + quartz-rich components. Feldspars are completely sericitized and minor hornblende is present as rims mantling clinopyroxene. In the eastern area (52°46′27″ N, 57°10′45″ W), the calc-silicate rock occurs as cm-wide layers intercalated with psammitic gneiss, immediately south of the Southwest Pond fault. The rock is greenish grey-weathering, medium grained, massive to diffusely banded and contains garnet, hornblende, chlorite, quartz and an opaque.

Amphibolite (Subunit 2a)

Amphibolite associated with metasedimentary gneiss occurs as km-scale zones and as outcrop-scale dykes and/or layers. The rock is black to dark grey-weathering, fine to medium grained and massive to gneissic. The mineral assemblage comprises hornblende + plagioclase + biotite ± clinopyroxene ± quartz and an opaque phase. Small quartzofeldspathic veins cut the amphibolite in many areas. Amphibolite dykes are concordant to discordant to the gneissosity and typically less than 1 m wide. In some areas, boudins and elongate pods interpreted as relict, deformed dykes occur within the gneissic banding (Plate 10). Alternatively, in some cases, amphibolite interpreted as concordant dykes may be of supracrustal origin.

Granitoid Rocks (Unit 4)

K-feldspar Megacrystic Granite to Granodiorite (Subunit 4p)

K-feldspar megacrystic granite to granodiorite is a major unit within the Alexis River map region. The unit occurs as

Plate 10. *Amphibolite pod (subunit 2a) in metasedimentary gneiss (subunit 2s; Mealy Mountains terrane).*

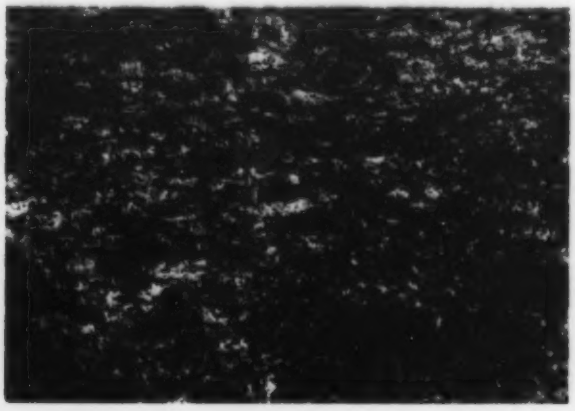


Plate 11. *'Pseudo-megacrystic' phase of K-feldspar megacrystic granite (subunit 4p). Note diffuse contacts of K-feldspar megacrysts (Mealy Mountains terrane). Lens cap is 5 cm in diameter.*

large elongate to oval-shaped intrusions in the eastern and central parts of the region as well as smaller enclaves and/or intrusions. In the southeastern corner, the K-feldspar megacrystic unit is associated with sillimanite-bearing metasedimentary gneiss.

In the White Bear Arm complex, K-feldspar megacrystic granite occurs in a large enclave within metagabbro (subunit 7r). The texture varies from strongly foliated and recrystallized to moderately foliated with K-feldspar megacrysts ranging 1 to 5 cm in length. The mineral assemblage consists of K-feldspar + plagioclase + quartz + biotite ± hornblende ± sphene ± zircon ± allanite and an opaque phase. Associated with the megacrystic granite on outcrop scale, are dykes and/or enclaves of the metagabbro unit.

K-feldspar megacrystic granite to granodiorite in the Gilbert River belt, occurs as large, northwest-trending intrusions, and as smaller, km-scale intrusions or enclaves. Mafic phases include biotite ± hornblende and an opaque phase. Characteristic of this unit, in the east of the Gilbert River belt, is a strong foliation or sub-gneissic augen fabric, defined by mafic phases wrapping K-feldspar megacrysts. In the central and western parts, the fabric is less strongly developed and a moderate foliation dominates.

In the Mealy Mountains terrane, K-feldspar megacrystic granite to granodiorite occurs as large, northwest-trending intrusions in the northern part of the terrane, and as interfingering bodies associated with metasedimentary gneiss in the southeast corner of the map region.

The fabric ranges from a weakly developed foliation to gneissic with a moderate foliation being the dominant fabric. The margins of the northwest-trending intrusions in the eastern part of the terrane are characterized by a 'pseudo-megacrystic' texture, in which the K-feldspar megacrysts are partially assimilated with the matrix component of the rock and grain boundaries are diffuse (Plate 11). In some areas, a complete gradation from euhedral K-feldspar megacrysts having well-developed grain boundaries to completely assimilated megacrysts was observed over tens of metres. In the southeast corner of the region, sillimanite-bearing metasedimentary gneiss is intruded extensively by lenses of K-feldspar megacrystic granite.

K-feldspar megacrysts are typically 2 to 3 cm long, and range from partially recrystallized to unrecrystallized. In several localities north of the Alexis River, the megacrysts are up to 10 cm long and are strongly attenuated and recrystallized. Hornblende, biotite, an opaque phase, and commonly, garnet are the mafic phases of the granite in this area, as opposed to garnet-absent assemblages in other areas. The presence of garnet, particularly near contact zones, suggests incorporation of garnet-bearing sediments into the granite matrix probably during intrusion.

The contacts between the metasedimentary gneiss and the K-feldspar megacrystic granite are defined by zones (tens to hundreds of metres wide) of 'mixed', strongly sheared granite having diffuse zones of metasedimentary gneiss, and granite pegmatites. Rare, rotated K-feldspar megacrysts suggest a dextral sense of movement along the contacts.

Foliated Granite (Subunit 4g)

Foliated granite occurs as a large intrusion in the Gilbert River belt, and as smaller bodies in the southeast corner of the Mealy Mountains terrane. A body of foliated granite intrudes granodioritic gneisses in the extreme western part of the area.

The intrusion in the Gilbert River belt consists of a granite to alkali-feldspar granite, which is red-, to white- to pink-weathering, coarse grained and weakly to moderately foliated. The mineral assemblage of the granite consists of K-feldspar + plagioclase + quartz + biotite + an opaque

phase ± hornblende ± garnet ± muscovite. To the southeast, an intrusion of K-feldspar megacrystic granite has a similar matrix component as the foliated granite. Although contact relationships between the two bodies were not observed in the field, the similarity suggests that the two intrusions may be in gradational contact.

In the Mealy Mountains terrane, two varieties of foliated granite occur:

i. Thin, linear zones south of the Southwest Pond fault, and in the extreme western portion of the region, intrude granodiorite gneiss (subunit 1b) and hornblende-bearing monzonite to syenite (subunit 4h). The rock is pink- to red-weathering, medium to coarse grained, moderately to strongly foliated and contains plagioclase + K-feldspar + quartz + biotite ± hornblende and an opaque phase.

ii. Fine to medium grained, red- to pink-weathering, weakly foliated to massive granite is characterized by a recrystallized, saccharoidal texture in the southeast corner. The mineral assemblage of the rock consists of plagioclase + K-feldspar + quartz + biotite + an opaque mineral ± garnet ± hornblende. The granite commonly occurs as veins, which postdate the fabric in the K-feldspar megacrystic granite (Plate 12), and small enclaves of partially assimilated K-feldspar megacrystic granite occur within the granite in a few localities.

Plate 12. *Recrystallized granite vein truncating fabric in K-feldspar megacrystic granite (subunit 4p; Mealy Mountains terrane).*

Foliated Granodiorite (Subunit 4b)

Foliated granodiorite (subunit 4b) occurs as a northwest-trending elongate belt in the northern part of the Mealy Mountains terrane, and as an irregularly shaped intrusion in the southeastern part of the region. Small, 1- to 2-km-scale enclaves or intrusions of granodiorite occur within other granitoid units in the southeastern corner of the area. The rock ranges from white-, to red-, to pink- to grey-weathering, medium to coarse grained, weakly to strongly foliated, and contains plagioclase + K-feldspar + quartz + biotite + an opaque phase ± hornblende ± garnet ± muscovite assemblages.

In many outcrops, the foliated granodiorite is gradational into granodiorite gneiss (subunit 1b) and foliated granite (subunit 4g), and concordant granitic veins intruding the granodiorite commonly give the rock a gneissic appearance.

Foliated Diorite to Quartz Diorite (Subunit 4d)

Foliated diorite to quartz diorite (subunit 4d) occurs as a large intrusion (informally named the Central diorite) in the central part of the Mealy Mountains terrane in association with the Alexis River anorthosite, and as small intrusions in the western part of the area. Within the Central diorite, the dominant rock type is grey-, to green- to brown-weathering, medium grained, homogeneous, moderately to strongly foliated diorite to quartz diorite (Plate 13). The mineral assemblage consists of plagioclase + quartz + hornblende + biotite ± garnet ± orthopyroxene ± clinopyroxene and an opaque phase. Hornblende is the dominant mafic phase, locally constituting up to 40 percent of the rock. Garnet is common, although not a ubiquitous phase, and porphyroblasts up to 5 cm in diameter are locally present near the contact of the intrusion (Plate 14). These crystals are typically rimmed by recrystallized plagioclase + quartz, a texture that suggests a partial replacement of the garnet. At one locality along the Alexis River (52°35'15" N, 57°12'10" W), orthopyroxene and clinopyroxene are stable in a strongly recrystallized phase of the diorite, indicating granulite-facies conditions.

Plate 13. *Strongly foliated, homogeneous diorite (subunit 4d; Mealy Mountains terrane). Lens cap is 5 cm in diameter.*

In the western part of the area, foliated diorite occurs as small intrusions or enclaves flanking the Upper Paradise River pluton. These rocks are similar in appearance and mineral assemblage to the Central diorite.

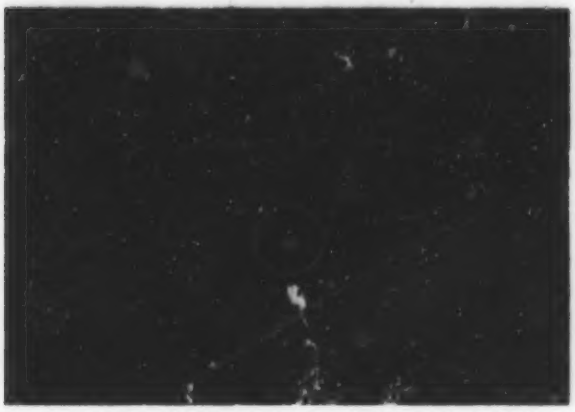


Plate 14. *Large garnet porphyroblasts in foliated diorite (subunit 4d). Note plagioclase + quartz reaction rims around garnets. (Near contact of diorite intrusion, Mealy Mountains terrane.) Lens cap is 5 cm in diameter.*

Syenite to Quartz Syenite (Subunit 4h)

A distinctive unit in the extreme northwest corner of the region is a white- to cream-weathering, medium-grained, strongly foliated and recrystallized, syenite to quartz syenite, locally gradational into monzonite. The mineral assemblage consists of hornblende + plagioclase + K-feldspar + quartz + biotite ± clinopyroxene and an opaque phase. The unit is distinguished from Unit 5 syenites and monzonites of the Upper Paradise River pluton (discussed below) in having a consistent strong foliation and being hornblende-rich. This unit is an extension of a dominantly granodioritic unit described by Gower *et al.* (1985) in the Paradise River region to the north.

Foliated Monzonite (Subunit 4m)

Unit 4 monzonitic rocks occur as small bodies in the southeastern part of the region. The rocks are pink-weathering, medium to coarse grained, moderately to strongly foliated and contain plagioclase + K-feldspar + quartz + biotite + hornblende + an opaque phase ± garnet. In some areas, these rocks are gradational into foliated granite (subunit 4g).

Muscovite-bearing Granite (Subunit 4u)

A small unit of muscovite-bearing granite, containing up to 20 percent muscovite occurs in the eastern edge of the map region. The rock is pink-weathering, strongly foliated, medium grained, saccharoidal textured and contains plagioclase + K-feldspar + quartz + muscovite + biotite and an opaque phase. Characteristic of the unit are abundant enclaves of sillimanite-bearing metasedimentary gneiss. In some cases, the enclaves are almost completely assimilated and only thin melanosome seams of biotite + sillimanite + muscovite are evident. The muscovite is present as a secondary phase overgrowing individual grains and aggregates of sillimanite.

Amphibolite (Subunit 4a)

Amphibolite associated with Unit 4 granitoid rocks occurs as concordant layers and discordant dykes, and as cm- to km-scale enclaves. The rock varies from black- to grey-weathering, fine to coarse grained, massive to strongly foliated and locally intruded by small quartzofeldspathic veins. The mineral assemblage consists of plagioclase + hornblende + biotite ± pyroxene ± chlorite and an opaque phase. In a few outcrops, plagioclase–porphyritic-amphibolite occurs as boudined and deformed dykes within K-feldspar megacrystic granite (Plate 15). Rare chilled margins and apophyses in amphibolite dykes are preserved in some outcrops, although margins of dykes are typically diffuse and locally exhibit a thin reaction zone of plagioclase + quartz, probably formed during intrusion of the dyke. In other areas, fine-grained amphibolitic enclaves or relict dykes are agmatized by intruding host granitoid rocks (Plate 16).

Plate 15. *Deformed plagioclase–porphyritic-amphibolite dyke (subunit 4a) in K-feldspar megacrystic granite (subunit 4p; Mealy Mountains terrane).*

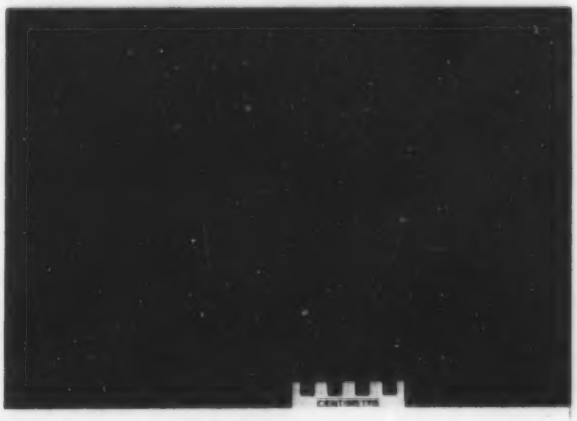


Plate 16. *Agmatized amphibolite enclave (subunit 4a) in quartz diorite (subunit 4d; Mealy Mountains terrane).*

Upper Paradise River Pluton (Unit 5)

The Upper Paradise River pluton is an informal name for a large, irregularly shaped intrusion in the western part of the region. The intrusion is characterized by a positive aeromagnetic signature and poor exposure and consists of four main rock types: (i) moderately to strongly foliated monzonite (subunit 5m), (ii) massive to weakly foliated K-feldspar megacrystic monzonite to quartz monzonite (subunit 5mp), (iii) moderately foliated syenite to quartz syenite (subunit 5y), and (iv) strongly foliated K-feldspar megacrystic syenite to quartz syenite (subunit 5yp). Subordinate mafic dykes (subunit 5a) are also present in this unit.

Associated with the Unit 5 granitoid rocks are small enclaves and/or intrusions of metagabbro (subunit 7r), which are similar to gabbros underlying the White Bear Arm complex in the northeast corner of the region.

Although age relationships between the various rock types are poorly known, the similarity in composition and distribution of the rock types suggest that they are part of a composite pluton.

Foliated Monzonite (Subunit 5m)

The dominant rock type within the Upper Paradise River pluton is a variably foliated and recrystallized monzonite. The rock is medium grained, moderately to strongly foliated and has a distinct rusty brown-weathering texture. The mineral assemblage consists of plagioclase + K-feldspar + quartz + biotite ± hornblende ± clinopyroxene ± orthopyroxene, and locally developed retrograde chlorite and epidote. Recrystallized orthopyroxene was observed at one locality in the central part of the pluton (52°41'30" N, 57°38'42" W). The rock exhibits a pervasive submylonitic fabric defined by strongly recrystallized microcline and perthitic feldspar having minor biotite and orthopyroxene. In a few areas, very minor 0.5- to 1.0-cm-long K-feldspar megacrysts (less than 5 percent) occur locally, particularly near contacts with mafic enclaves. Mafic phases commonly occur as small, mm-scale, recrystallized domains in a matrix of K-feldspar, quartz and plagioclase.

K-feldspar Megacrystic Monzonite (Subunit 5mp)

The most distinctive rock type within the Upper Paradise River pluton is a K-feldspar megacrystic monzonite to quartz monzonite. The rock occurs as irregular-shaped bodies within the pluton, defined by relatively high positive aeromagnetic signatures. Contact relationships with other units were not observed.

The rock is brown- to grey-weathering, medium to coarse grained, massive to weakly foliated, and characterized by unrecrystallized to partially recrystallized K-feldspar megacrysts. The megacrysts are euhedral to subhedral, comprise 10 to 50 percent of the rock, and range from 1 to 4 cm in length (Plate 17). The K-feldspar megacrysts vary

Plate 17. *Weakly foliated to massive K-feldspar megacrystic monzonite (subunit 5mp). K-feldspars locally have recrystallized rims (Mealy Mountains terrane). Lens cap is 5 cm in diameter.*

from relatively fresh, and unrecrystallized, typically with very thin (0.5- to 1 mm-wide) recrystallized rims, to megacrysts that are moderately recrystallized. The rock is usually massive, although locally, a weakly developed fabric is defined by preferred alignment of K-feldspar megacrysts, and, in rare cases, mafic phases are aligned. The mineral assemblage consists of plagioclase + K-feldspar + quartz + biotite + hornblende ± clinopyroxene and an opaque phase. Where the K-feldspar megacrysts comprise only 5 percent of the rock, the matrix component is similar to the monzonite of subunit 5m, except that it has a weaker fabric.

Syenite to Quartz Syenite (Subunit 5y)

The western part of the Upper Paradise River pluton is underlain predominantly by a syenitic to quartz–syenite unit (subunit 5y). The rock is white- to pink- to buff-weathering, fine to medium grained, and moderately foliated. The mineral assemblage of the unit consists of plagioclase + K-feldspar + quartz + biotite + hornblende ± clinopyroxene + an opaque phase. In some areas, a sub-gneissic fabric is developed, defined by thin (0.25-cm-wide) quartz lenses parallel to the main fabric.

In thin section, mafic phases are typically formed in 0.5- to 1.0-cm diameter recrystallized domains. In some areas, the domains are attenuated resulting in a moderately developed fabric. A very minor but distinctive rock type found as enclaves within the megacrystic monzonite is a pink-weathering, fine- to medium-grained, recrystallized quartz syenite, characterized by a quartz 'eye' fabric. Although relationships between the quartz-syenite enclaves and syenitic rocks in the west of the pluton were not observed, they are interpreted as being the same unit.

K-feldspar Megacrystic Quartz Syenite (Subunit 5yp)

K-feldspar megacrystic quartz syenite underlies the southeast part of the Upper Paradise River pluton and occurs

as a single outcrop in the central part of the pluton. The rock is rusty brown-weathering, medium to coarse grained, moderately to strongly foliated and characterized by 10 to 30 percent K-feldspar megacrysts. The mineral assemblage is K-feldspar + plagioclase + quartz + biotite ± hornblende and an opaque phase. Several bodies of Units 4 and 5 granitoid rocks occur within the megacrystic quartz syenite. However, age relationships between the various rock types were not observed.

Mafic Dykes (Subunit 5a)

An unequivocal mafic dyke associated with granitoid rocks of the Upper Paradise River pluton was observed in only one locality in the southern part of the pluton, intruding K-feldspar megacrystic alkali-feldspar syenite (57°40′56″ W, 52°35′56″ N). The dyke is a medium-grained, grey-weathering, recrystallized and foliated gabbro dyke, containing plagioclase + biotite + clinopyroxene + olivine + garnet and an opaque phase. The dyke truncates a strong fabric in K-feldspar megacrystic syenite (subunit 5yp) at a shallow angle and shows that intrusion of the dyke postdated the development of the fabric (Plate 18). Also at this locality, a concordant, fine-grained, black-weathering, recrystallized amphibolite layer, containing plagioclase + hornblende + biotite and an opaque phase is also present. The distinction of this layer as a dyke or enclave could not be established due to its poor exposure.

Plate 18. *Discordant and concordant amphibolite dykes (subunit 5a) intruding K-feldspar megacrystic alkali-feldspar syenite (subunit 5yp; Upper Paradise River pluton).*

Isolated intrusions of monzonite, K-feldspar megacrystic monzonite, and K-feldspar megacrystic quartz syenite occur outside the main body of the Upper Paradise River pluton in the southern part of the area. These rocks are identical to those within the pluton, and are interpreted as satellite intrusions to the Upper Paradise River pluton. One of these intrusions along the southern boundary of the map region, consists of foliated monzonite (subunit 5m) with a core zone of K-feldspar megacrystic monzonite (subunit 5mp). Intrusive relationships between the two units were not observed.

Associated with the monzonitic and syenitic rocks of the Upper Paradise River pluton, are small intrusions or enclaves of metagabbro, which are similar to gabbroic rocks in the White Bear Arm complex. Age relationships between the monzonitic and syenitic rocks and the gabbroic zones were not observed within the pluton. However, Gower *et al.* (1985, 1987) note that monzonitic rocks and associated gabbro occur to the east and north of the study area and suggested that several intrusive phases of both monzonite and gabbro were present. A similar relationship between these rocks may be applicable for the Upper Paradise River pluton.

Alexis River Anorthosite (Unit 6)

Within the study area, the Alexis River anorthosite is a narrow (1- to 3-km-wide) belt that links extensions of the unit mapped by Gower *et al.* (1985, 1987). Although exposure of the anorthosite is poor in the study area, extrapolation is based partly on a relatively low aeromagnetic signature.

In the study area, the Alexis River anorthosite consists of four rock types: (i) anorthosite to leucogabbro (subunits 6n/l), (ii) leucogabbro (subunit 6l), (iii) anorthosite (subunit 6n) and (iv) amphibolite (subunit 6a).

Anorthosite to Leucogabbro (Subunits 6n/l)

The most dominant type is a white-weathering, medium- to coarse-grained, moderately to strongly foliated, recrystallized anorthosite to leucogabbro (subunits 6n/6l). The fabric of the rock is defined by 1- to 3-cm-long attenuated aggregates of hornblende, biotite, clinopyroxene and an opaque phase. Biotite mantles recrystallized hornblende, and relict clinopyroxene grains are rimmed by recrystallized hornblende and biotite in a few localities.

Leucogabbro (Subunit 6l)

The second rock type is a dark-weathering, coarse to very coarse-grained, massive to gneissic leucogabbro to leuconorite (Plate 19). In one locality (52°50′55″ N, 57°08′40″ W), near the eastern margin of the map region, orthopyroxene and clinopyroxene crystals up to 80 cm long are present in a matrix of recrystallized plagioclase. In the same outcrop, the rock is gradational into a leucogabbro with a well-developed gneissosity, defined by discontinuous layers of hornblende, pyroxene and an opaque phase alternating with a recrystallized plagioclase matrix.

Anorthosite (Subunit 6n)

The third rock type is a white-weathering, massive to moderately foliated, recrystallized anorthosite (subunit 6n). Plagioclase comprises up to 90 percent of the rock type and contours subordinate hornblende, biotite, clinopyroxene and an opaque phase. In one locality, in the northwest part of the unit, a moderate to strong fabric is defined by 5- to 10-cm-wide mafic-rich layers in a matrix of recrystallized plagioclase and may represent a relict igneous layering (Plate 20).

Plate 19. *Coarse-grained, recrystallized leucogabbro of the Alexis River anorthosite (subunit 6l; Gilbert River belt).*

Plate 20. *Igneous layering in Alexis River anorthosite (subunit 6n). Dark layers consist of hornblende, pyroxene and opaque minerals (Gilbert River belt).*

Within the Alexis River region, the anorthosite ranges from 1 km wide in the east to 4 km in the western part of the belt. The apparent thickening of the belt in the west suggests that the anorthosite has been folded into a synformal/antiformal structure about a northwest-trending axis (see section on Structure, page 18).

Amphibolite (Subunit 6a)

Amphibolite associated with the Alexis River anorthosite is a minor unit and occurs as outcrop-scale enclaves in only one locality in the eastern portion of the anorthosite and as dykes intruding the anorthosite in the northwestern region. Enclaves are black-weathering, medium grained, schistose and intruded by thin (1- to 2-cm-wide) quartzofeldspathic veins. One outcrop in the northwest of the area, is intruded by two discordant (postfabric) amphibolite dykes. The dykes are brown-weathering, medium grained, massive to weakly foliated, locally plagioclase porphyritic and exhibit fine-grained chilled margins (Plate 21). The mineral assemblage

Plate 21. *Discordant amphibolite dykes (subunit 6a) intruding Alexis River anorthosite (subunit 6n; Gilbert River belt).*

consists of plagioclase + hornblende + an opaque phase and chlorite.

Mafic Intrusive Rocks (Unit 7)

Gabbroic rocks are divided into three main rock types: (subunit 7r) melanogabbro, metanorite; (subunit 7l) leucogabbro, leuconorite; and (subunit 7f) granulite facies, two-pyroxene metanorite. Minor amphibolite dykes and/or enclaves (subunit 7a) associated with gabbroic rocks are also present.

Metagabbro (Subunit 7r)

The dominant type is a grey- to green-weathering, medium-grained, massive to weakly foliated gabbro. The gabbro underlies the White Bear Arm complex in the northeast corner of the region, and occurs as enclaves and/or small intrusions in granitoid rocks and metasedimentary gneiss. It is also associated with monzonitic and syenitic rocks in the Upper Paradise River pluton. The texture and mineral assemblage of the unit is relatively consistent throughout the area, although local variations in mafic mineral content and texture are present. The mineral assemblage of the unit consists of plagioclase + hornblende ± orthopyroxene ± clinopyroxene ± olivine + an opaque phase ± chlorite. Corona structures of olivine ± pyroxene cores having single or double rims of recrystallized pyroxene ± amphibole occur in some areas (Figure 8c), and are similar to those described by Gower *et al.* (1985, 1987) and Prevec (1987).

In the extreme northwest corner of the region, small-scale (tens of metres) intrusions of a black-weathering, coarse-grained, massive metagabbro are present within strongly foliated syenite to monzonite (subunit 4h). Characteristic of this gabbro is a coarse corona texture consisting of igneous clinopyroxene and orthopyroxene grains partially to completely pseudomorphed by hornblende, which are rimmed by recrystallized garnet haloes.

In the gabbro unit, igneous layering was observed in one locality south of the Alexis River, in the eastern part of the region. The layering is defined by alternating cm-wide hornblende-rich and plagioclase-rich layers (Plate 22).

Plate 22. *Igneous layering preserved in leucogabbro (subunit 7l; Mealy Mountains terrane).*

Leucogabbro to Leuconorite (Subunit 7l)

The second rock type of Unit 7 is a white- to grey-weathering, medium- to coarse-grained, massive to moderately foliated leucogabbro (subunit 7l). The unit occurs as small enclaves and/or intrusions in orthogneiss, foliated granitoid rocks and metasedimentary gneiss in the Gilbert River belt and the Mealy Mountains terrane. The rock is typically coarse grained, massive to weakly foliated, and characterized by large hornblende aggregates and/or crystals, partially pseudomorphing clinopyroxene. In a few outcrops, just north of the Alexis River, hornblende ± pyroxene mineral aggregates have thin chlorite rims, resulting from replacement of hornblende or hydration of relict pyroxene grains.

Magnetite crystals up to 4 cm in diameter are present in coarse-grained leucogabbro enclaves within K-feldspar megacrystic granite in the extreme southeast corner of the region, south of the Alexis River.

Gabbronorite (Subunit 7f)

A third, minor rock type of Unit 7 is a brown- to grey-weathering, fine-grained, recrystallized, two-pyroxene gabbronorite. The rock is restricted to a few outcrops in the White Bear Arm complex in the extreme northeast corner of the region. It occurs as m-scale outcrops intruding the coarser subunit gabbro, and in one locality (52°59'25" N, 57°01'55" W) in the White Bear Arm complex, intrudes a pyroxene-bearing, mylonitic granite (subunit 4g), which is an enclave within the subunit 7r gabbro. Gower *et al.* (1985, 1987) mapped similar rocks in the Paradise River and Port Hope Simpson regions. They interpreted the isolated occurrence of the gabbronorite as being feeder dykes for the later coarser grained gabbro of subunit 7r. Although relationships between the granulite-facies gabbronorite and the medium- to coarse-grained gabbro (subunit 7r) are not well established in the region, a similar interpretation is proposed here.

Amphibolite (Subunit 7a)

Amphibolite associated with gabbroic rocks is a minor unit and occurs as dykes and as outcrop-scale enclaves. The rock is dark grey-weathering, fine to medium grained and massive to foliated. The mineral assemblage consists of plagioclase + hornblende + biotite ± pyroxene ± chlorite and an opaque phase.

Pegmatite (Unit 8)

Alkali-feldspar granite and syenogranite pegmatite are common intrusive phases into all units in the region with the exception of post-Grenvillian mafic dykes. Although the majority of pegmatite occurrences are limited to outcrop scale, an extensive pegmatite field was mapped in the northeast part of the Gilbert River belt. (Outcrop-scale pegmatites are shown on accompanying 1:100 000 scale map). Much of the underlying area is poorly exposed and delineation of the field is based on extrapolation from the adjacent Paradise River region and a moderately high aeromagnetic signature. The pegmatite is white- to red-weathering, coarse to very coarse grained, massive and exhibits graphic granite texture in some outcrops. The mineral assemblage consists of K-feldspar + plagioclase + quartz + biotite + muscovite ± garnet, and in one locality tourmaline (indicated on Figure 4).

Deformed Pegmatites

Deformed pegmatite ranges from moderately folded veins to remnant, strongly sheared pods and relict K-feldspar crystals, the latter usually confined to orthogneiss and strongly deformed units. In the extreme northwest corner of the region, alkali-feldspar granite pegmatites having strongly sheared margins intrude a massive gabbro of subunit 7r. The absence of a fabric in the gabbro and in the interior of the vein suggests a forceful emplacement of some of the pegmatites. In other areas, particularly in granitoid units, moderately folded pegmatite veins have undeformed, or weakly deformed margins indicating deformation subsequent to a relatively passive intrusive event.

Undeformed Pegmatites

Massive, undeformed granite pegmatite veins are common in most units, particularly in granitoid rocks, and, in many cases, crosscut other generations of undeformed pegmatites as well as obviously older, deformed pegmatites. The veins are characterized by very coarse-grained K-feldspar and plagioclase and medium- to coarse-grained quartz grains. Biotite and muscovite plates up to 8 cm diameter occur in a few localities, where the pegmatites intrude metasedimentary gneiss. Magnetite grains exceed 6 cm in

diameter in one locality north of the Alexis River (magnetite occurrence, mt on Figure 4). The pegmatite veins range from cm- to m-wide, are usually straight and truncate pre-existing fabrics, although in some areas the veins follow pre-existing, variably trending fractures or zones of weakness parallel to the fabric.

Mylonitic and Cataclastic Rocks (Unit 10)

Mylonitic and cataclastic rocks in the region were observed at outcrops within airphoto lineaments and define ductile or brittle faults.

Mylonites and Submylonites (Subunit 10m)

In the White Bear Arm complex, a single outcrop of a mylonitic granite occurs as an enclave within massive to weakly foliated gabbro of subunit 7r. The granite is pink-weathering, fine grained, recrystallized with a moderately developed C−S fabric, implying a dextral (west over east) shear sense and a dominant vertical component.

The northwest part of the Southwest Pond fault is marked by a zone of submylonitic metasedimentary gneiss. The gneiss is thinly banded, defined by alternating plagioclase-rich and garnet + biotite-rich bands. Garnets occur as attenuated, strongly recrystallized aggregates having aspect ratios up to 10:1 and as large, dextrally rotated porphyroblasts. Associated with the gneiss are lenses of fine-grained, strongly foliated amphibolite, which are probably representative of deformed relict mafic dykes.

Cataclastic Rocks (Subunit 10c)

Cataclastic rocks in the region occur as breccia in northeast-trending late brittle faults of probable post-Grenvillian age. The rocks are typically red-weathering, strongly hematized and chloritized, fine to very fine grained, and intruded by abundant quartz veins. Disseminated pyrite (1 percent) was found associated with chlorite, epidote and quartz veining within a brittle fault in the eastern portion of the region. Along the northern part of the Paradise River, two of the northwest faults are marked by 5-m-wide quartz veins, associated with breccia and alteration zones and are on strike with faults related to the Sandwich Bay graben (Gower *et al.*, 1985). The amount and sense of displacement is unknown for the faults. However, continuation of small units across the faults suggests that the amount of displacement is probably minor.

Post-Grenvillian Rocks (Units 12 and 13)

Two suites of post-Grenvillian mafic dykes have been mapped within the Alexis River region. These include extensions of two northeast-trending gabbro dykes (subunit 12g) in the Paradise River region (Gower *et al.*, 1985) and small (cm-scale), fine-grained diabase dykes (Unit 13) related to a suite of Paleozoic diabase dykes (Gower *et al.*, 1985, 1987) termed the Sandwich Bay dykes (Murthy *et al.*, 1989a).

Coarse-grained, Gabbro Dykes (Subunit 12g)

Two dykes of subunit 12g were mapped in the eastern and western parts of the Alexis River region. They occur as isolated, single outcrops, which are extrapolated from dykes in the Paradise River region (Gower *et al.*, 1985); these are indicated on Figure 4. The dykes are grey- to green-weathering, coarse grained, massive and characterized by an intergranular to ophitic gabbroic texture. The mineral assemblage consists of plagioclase + K-feldspar + hornblende + biotite + clinopyroxene + olivine + an opaque phase ± chlorite ± serpentine. The presence of K-feldspar is a characteristic feature and ranges from 5 percent in the eastern dyke to 15 percent in the western dyke. Similar K-feldspar contents are characteristic of the interpreted extension of the dykes in the Paradise River region to the north (Gower *et al.*, 1985). The variation in K-feldspar is probably due to different levels of intrusion of the dykes. Although undeformed, the dykes show evidence of alteration by sericitization of plagioclase and K-feldspar and chloritization of hornblende and pyroxene. The alteration is probably related to late deuteric effects during uplift and cooling. Recognition of these dykes in the Alexis River region extends the strike lengths of the dykes in the Paradise River region to 100 km for the western dyke and in excess of 150 km for the eastern dyke.

Quartz Veins (Subunit 12q)

Two northeast-trending (approximately 60° azimuth), 4- to 5-m-wide quartz veins were mapped in the northwest corner of the area, along the Paradise River. The rock is white-weathering, fine to very fine grained, and is associated with fault breccia and alteration zones containing chlorite, epidote and muscovite. The quartz veins are interpreted to be associated with the late (post-Grenvillian) Paradise River fault zone (Gower *et al.*, 1985). The Paradise River and the Eagle River fault zones link up with similar structures in the Sandwich Bay map region (Gower *et al.*, 1983) and define the Sandwich Bay graben. They suggest that the graben is probably of similar age to the Double Mer and Lake Melville grabens farther to the northwest (Gower *et al.*, 1986c).

In the St. Lewis River region, Gower *et al.* (1988a) described three, north- to northwest-trending quartz veins up to 400 m wide and 20 km long. They interpret the veins as being coeval with similar trending post-Grenvillian mafic dykes.

Fine-grained Diabase Dykes (Unit 13)

The second suite of dykes (Unit 13) were mapped at two localities, in the east and along the Paradise River in the western part of the region. The dykes are 10 to 40 cm wide, black- to grey-weathering, fine grained, massive and possess well-defined chilled margins against the country rock (Plate 23). The western diabase dyke intrudes strongly foliated diorite (subunit 4d). The eastern dyke intrudes a granitic gneiss (subunit 1g). The mineral assemblage of the dykes

Plate 23. *Fine-grained, post-Grenvillian diabase dyke (Unit 13), intruding foliated quartz diorite (subunit 4d; Upper Paradise River, Mealy Mountains terrane).*

consist of plagioclase + clinopyroxene + orthopyroxene + biotite + an opaque phase + olivine ± chlorite. Plagioclase occurs as partially sericitized, euhedral to subhedral laths, as phenocrysts, and in the groundmass. Pyroxenes and olivine form small (0.2 to 0.4 mm) rounded grains, which are partially altered to biotite and chlorite. The alteration of mafic phases is probably a result of late deuteric effects.

Gower *et al.* (1985, 1987) described similar dykes in the Paradise River and Port Hope Simpson regions. Murthy *et al.* (1989a) reported a date of 327 ± 13 Ma (K–Ar, whole-rock) from one of these dykes in the Sandwich Bay area.

Although age relations between subunit 12g and Unit 13 were not observed in the study area, Gower *et al.* (1985) note that fine-grained diabase dykes (Unit 13) postdate coarse-grained gabbro dykes (Unit 12) in the Sandwich Bay area.

STRUCTURE

The regional structure of the Alexis River map area is dominated by a pervasive northwest trend in the northeast and a variable west to northeast trend in the south and northwest. The trends are developed in all units with the exception of post-Grenvillian dykes. Regional trends and structures are indicated in Figure 6.

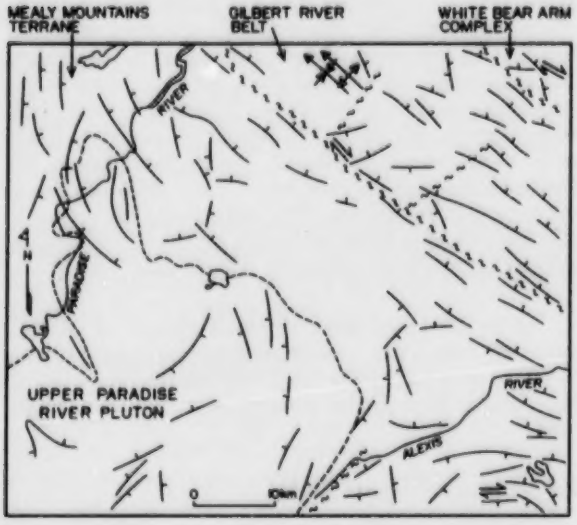
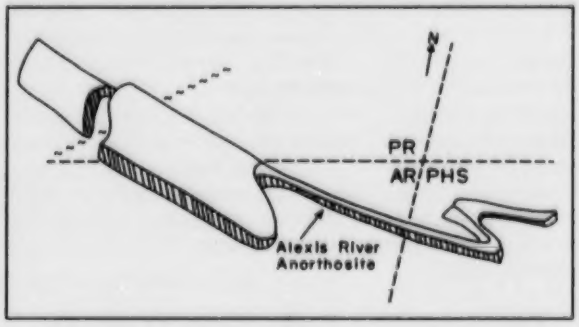


Figure 6. *Major structures and subdivision in the Alexis River map region.*

In the White Bear Arm complex, fabrics are limited to a weak foliation in metagabbro and a gneissosity in paragneiss and granite enclaves. A granite enclave within the gabbro is characterized by a strong, submylonitic fabric. The Gilbert River fault (Gower *et al.*, 1987), is interpreted from a strong airphoto and aeromagnetic signature and extrapolation from adjacent areas. However, no outcrop was observed.

The Gilbert River belt is characterized by a pervasive, northwest-trending foliation or gneissosity. The northwest part of the Alexis River anorthosite is interpreted on the map as a northwest-plunging antiformal/synformal structure. Mapping by Gower *et al.*, (1986a) to the north and aeromagnetic signatures suggest that the southern limb of the anorthosite has thickened as a result of folding about northwest-plunging axes. Figure 7 shows a regional schematic 3-D structural interpretation of the Alexis River anorthosite, including data from the Port Hope Simpson and Paradise River regions (Gower *et al.*, 1985, 1987).



AR - Alexis River map region
PHS - Port Hope Simpson map region
PR - Paradise River map region

Figure 7. *Schematic 3-D interpretation of regional structure of the Alexis River anorthosite. Interpretation includes data from the present study area and from the Port Hope Simpson region (Gower* et al., *1987) and the Paradise River region (Gower* et al., *1985).*

Fabrics in the Mealy Mountains terrane show a regional trend varying from northwesterly, near the boundary with the Gilbert River belt, west to northwest in the southeast corner of the region to a northward curvature of the fabric in the west and northwest. Fold styles are typically complex, ranging from open to tight Z and S folds in orthogneiss and granitoid rocks to isoclinal and typically transposed structures in metasedimentary gneiss (Plates 24 and 25). Fold axes generally plunge moderately toward the northwest, although locally, tightly folded layers in orthogneiss exhibit subhorizontal axes. In the southeastern corner, folds in metasedimentary gneiss, defined by an alternating north- and south-dipping gneissosity, imply the presence of fold axes that plunge shallowly toward the west. Mineral lineations and roddings, measured on foliation planes, typically plunge moderately toward the northwest in the Gilbert River shear belt, and vary from a shallow to moderate plunge toward the northwest to north in the Mealy Mountains terrane.

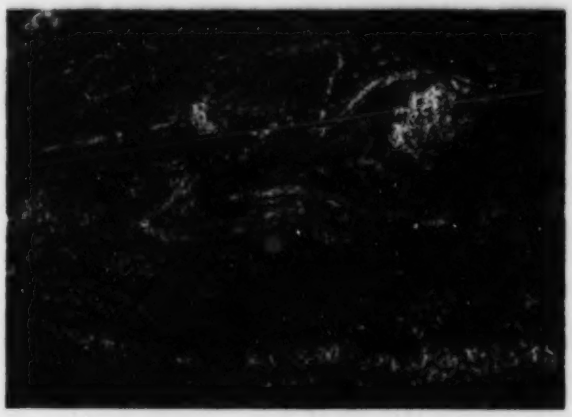


Plate 24. *Z-folds in well-banded metasedimentary gneiss (subunit 2s; Mealy Mountains terrane). Pencil is 15 cm long.*

Plate 25. *Open M-folds in well-banded granite gneiss (subunit 1g). Banding enhanced by concordant granite veins (Gilbert River belt).*

Kinematic indicators, in particular rotated porphyroblasts, and rare C–S fabrics (Plates 8 and 26) coupled with mineral lineations found along or near contacts, suggest a dextral shear sense. Attenuated garnets in metasedimentary gneiss along the southern boundary of the Gilbert River belt show aspect ratios up to 10:1 (Plate 7). Gower *et al.* (1987) proposed a regional kinematic framework, in which the Mealy Mountains terrane has moved dextrally with respect to the Lake Melville terrane (including the Gilbert River belt).

Plate 26. *Mylonitic granite (subunits 4g/10m) showing C–S fabric suggesting dextral (east over west movement). Enclave in gabbro of White Bear Arm complex.*

Contacts of K-feldspar megacrystic granite and metasedimentary gneiss in the southeast corner are marked by metre to tens-of-metres-wide 'mixed' zones characterized by dextrally rotated K-feldspar megacrysts in a sheared matrix of granite and metasedimentary gneiss.

Small, cm-scale shear zones having variable shear sense are a common structural feature in granitoid rocks. Pre-existing fabrics are rotated parallel to the shear zone (Plate 27) and in many cases retrograde muscovite and chlorite are developed within the zone.

Plate 27. *Small-scale dextral shear zone in K-feldspar megacrystic granite (subunit 4p; Alexis River, Mealy Mountains terrane). Pencil is 15 cm long.*

Late (post-Grenvillian) northeast-trending, brittle to ductile faults, are marked by extensive hematization, chloritization, quartz veining and fracturing, and locally by strong, quartz-defined fabrics. In the extreme northwest corner, along the Paradise River, brittle faults are marked by 060°-trending, 5-m-wide quartz veins and associated fine-grained fault breccia.

METAMORPHISM

Metamorphic grade in the Alexis River map region ranges from middle- to upper-amphibolite facies showing evidence that granulite facies was locally attained. Retrogression to lower-amphibolite facies is locally developed in most units. Greenschist-facies assemblages occur within late brittle faults and fractures. The mineral assemblages for all units are summarized in Table 1.

Distribution of diagnostic metamorphic minerals and textures in pelitic gneiss, granitoid rocks and mafic rocks are shown in Figure 8.

MAFIC ROCKS

In the White Bear Arm complex, metagabbroic rocks (Unit 7) contain recrystallized hornblende + plagioclase ± clinopyroxene and orthopyroxene assemblages. Hornblende occurs as partial to complete pseudomorphs or replacement of igneous clinopyroxene and orthopyroxene. Plagioclase is usually recrystallized, although unrecrystallized intergranular and ophitic textures are preserved in some areas. Granulite-facies assemblages of recrystallized plagioclase + orthopyroxene ± clinopyroxene and an opaque phase are present in small, outcrop-scale enclaves or dykes of fine-grained gabbronorite.

In the Gilbert River belt and the Mealy Mountains terrane, km-scale enclaves or intrusions of metagabbroic rocks contain similar assemblages and textures to the White Bear Arm complex and are interpreted as the same unit.

CORONA TEXTURES

Corona textures are locally well developed in gabbro and leucogabbro (subunits 7r and 7l). Relict igneous olivine occurs locally as a fresh or serpentinized core phase having double-rimmed coronas of amphibole ± orthopyroxene ± spinel (hercynite) in contact with the plagioclase. A generalized reaction for the formation of this assemblage has been discussed by Griffin and Heier (1973) and Gardner and Robins (1974) and is indicated by:

Plagioclase + olivine + magnetite + H_2O → orthopyroxene + amphibole + hercynite.....R1

Biotite coronas are locally developed around anhedral opaque (magnetite?) grains in metagabbroic enclaves (subunit 7r) in the Mealy Mountains terrane. The formation of biotite may result from the hydration of magnetite and reaction with K-feldspar via the reaction (Wones and Eugster, 1965):

Magnetite + K-feldspar + H_2O → biotite + quartz.....R2

In the farthest northwest corner of the region, a small zone of metagabbro (subunit 7r) is characterized by the appearance of garnet as a coronal phase marginal to aggregates of relict orthopyroxene, clinopyroxene and minor olivine. Both clinopyroxene and orthopyroxene are partially pseudomorphed by hornblende. The hornblende is interpreted to have formed after the development of garnet coronas because hornblende grains were observed to overgrow garnet. Garnet-forming reactions have been investigated in olivine-bearing metagabbros by Jenkins and Newton (1979) and O'Neill (1981). A possible reaction for the formation of garnet coronas in subunit 7r gabbros is:

Orthopyroxene + clinopyroxene + plagioclase + spinel → garnet.....R3

A small zone of fine-grained gabbronorite (subunit 7f) in the White Bear Arm complex, interpreted as a dyke, consists of a granulite-facies assemblage of polygonal orthopyroxene and clinopyroxene associated with recrystallized plagioclase.

GRANITOID ROCKS

Enclaves of pyroxene-bearing, strongly recrystallized and foliated granitic rocks (subunit 4g) are also present within the metagabbro. One sample (VN91-467) contains garnet co-existing with metamorphic orthopyroxene and clinopyroxene, which are partially pseudomorphed by hornblende indicating the granulite to upper-amphibolite retrograde reaction (Wells, 1977):

Orthopyroxene + plagioclase + H_2O → hornblende + garnet + quartz.....R4

In the Mealy Mountains terrane, granulite-facies dioritic rocks (subunit 4d) occur as enclaves within granitoid rocks and metasedimentary gneiss. The dioritic rocks have a strongly recrystallized, granoblastic texture defined by polygonal orthopyroxene ± clinopyroxene grains in a plagioclase-rich matrix. Minor hornblende developed along pyroxene grain margins suggests the operation of reaction R4.

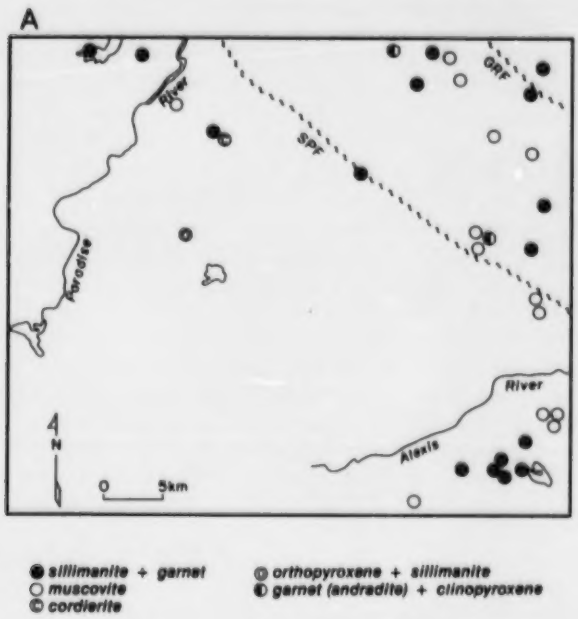
A common feature of granitoid rocks in both the Gilbert River belt and the Mealy Mountains terrane is the development of thin (less than 0.3-mm-wide) sphene rims around anhedral opaque grains in contact with plagioclase

Table 1. Mineral assemblages in granitoid rocks, paragneiss and mafic rocks

Rock Unit	Rock type	Assemblage
Orthogneiss		
1a	amphibolite gneiss	pl + hbl + kfs + qtz ± bi ± ga ± zir ± sp
1b	granodiorite gneiss	pl + kfs + qtz + bi + opq ± hbl ± ga ± zir ± sp ± all ± ap
1d	diorite gneiss	pl + hbl + bi + kfs + qtz ± ga ± zir
1g	granite gneiss	pl + kfs + qtz + bi ± hbl ± opq + ga ± zir ± sp ± all ± ap ± sp
1m	monzonite gneiss	pl + kfs + qtz + hbl + bi + ga + zir + opq
1p	K-feldspar megacrystic granite to granodiorite gneiss	pl + kfs + qtz + bi ± hbl ± ga + opq ± sp ± all ± zir ± ap
Supracrustal Rocks		
2a	amphibolite	pl ± qtz + hbl ± bi ± cpx ± sp ± zir
2c	calc-silicate rocks	pl + qtz ± kfs + cpx + ga ± hbl
2s	sillimanite-bearing pelitic gneiss	pl + kfs + qtz + bi + si ± ga ± mu ± crd ± opx ± zir ± sp ± ap + opq
2u	muscovite-bearing pelitic gneiss	pl + kfs + qtz + mu + bi ± si ± ga ± zir ± sp + opq
2w	psammite gneiss	pl + kfs + qtz + bi ± si ± ga ± mu ± zir ± sp + opq
2x	diatexite	pl + kfs + qtz + bi ± ga ± si ± sp ± zir + opq
Granitoid Rocks		
4a	amphibolite	pl ± qtz + hbl ± bi ± ga ± sp ± zir + opq
4b	granodiorite	pl + kfs + qtz + bi ± hbl ± ga ± sp ± zir ± all ± ap + opq
4d	diorite	pl + qtz + kfs + hbl + bi ± ga + cpx + opx ± sp ± zir ± all + opq
4g	granite	pl + kfs + qtz + bi ± hbl ± ga ± sp ± zir ± all ± ap + opq
4h	syenite to monzonite	pl + qtz ± kfs + hbl + bi ± ga ± cpx ± zir ± all + opq
4m	monzonite to quartz monzonite	pl + kfs + qtz + bi ± hbl ± ga + opq ± sp ± all ± zir
4p	K-feldspar megacrystic granite to granodiorite	pl + kfs + qtz + bi ± hbl ± ga ± zir ± sp ± all + opq
5m	monzonite	pl + kfs + qtz + hbl + bio + cpx + sp ± zir + opq
5mp	K-feldspar megacrystic monzonite	pl + kfs + qtz + bi ± hbl ± ga ± cpx ± sp ± zir + opq
5y	syenite to quartz syenite	pl + kfs + qtz + bi + hbl ± cpx ± ga ± opx + opx ± zir
5yp	K-feldspar megacrystic alkali feldspar syenite	kfs + qtz + pl + bi ± hbl ± zir ± sp + opq
5a	mafic dykes	pl + bi + ga + cpx + ol + opq
Anorthosite		
6a	amphibolite	pl ± qtz + hbl + bi ± cpx + opq
6n	anorthosite	pl ± qtz + hbl + bi ± cpx ± opx + opq
6l	leucogabbro	pl ± qtz + hbl + bi ± cpx + opx + opq
Metagabbro		
7a	amphibolite	pl ± qtz + hbl ± bi ± cpx + opq
7r	gabbro to norite	pl ± qtz + hbl ± bi ± cpx ± opx ± ol ± ga + opq
7l	leucogabbro	pl ± qtz + hbl + bi ± cpx ± opx ± ol ± ga + opq
Pegmatite		
8	pegmatite	pl + kfs + qtz + bi ± ga ± mu ± tour + opq
Post-Grenvillian Rocks		
12g	gabbro dykes	pl + qtz + kfs + hbl + bi + cpx ± opx ± ol
12q	quartz veins	qtz + chl ± ep ± hem
13	diabase dykes	pl ± qtz + cpx ± opx ± ol + opq

Mineral Abbreviations

all–allanite
ap–apatite
bi–biotite
chl–chlorite
cpx–clinopyroxene
crd–cordierite
ep–epidote
ga–garnet
hbl–hornblende
kfs–K-feldspar
mu–muscovite
ol–olivine
opq–opaque
opx–orthopyroxene
pl–plagioclase
qtz–quartz
sp–sphene
zir–zircon



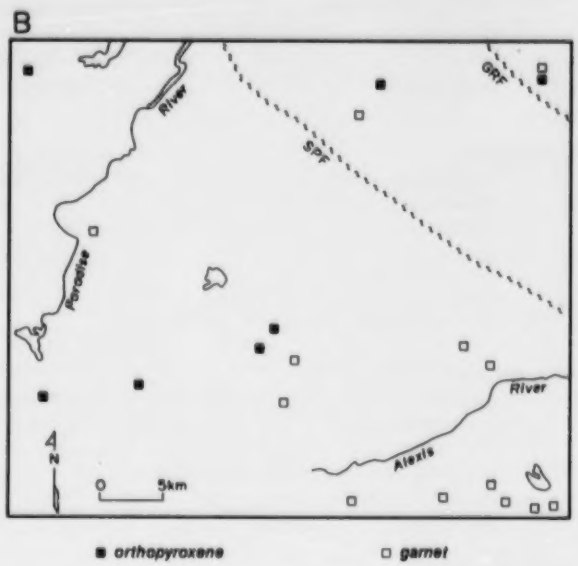
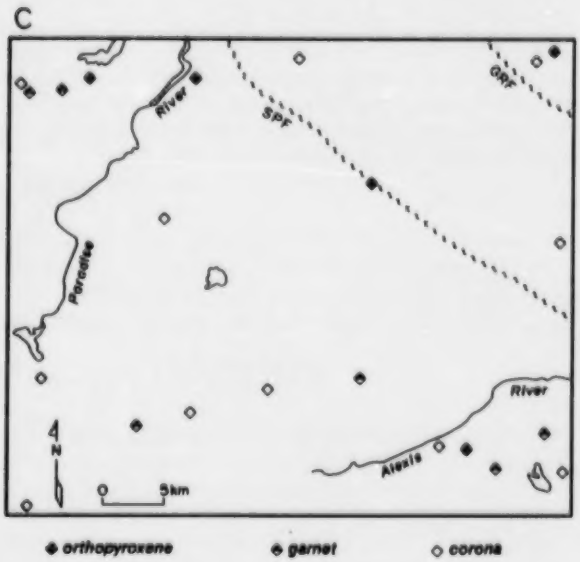


Figure 8. *(a) Distribution of diagnostic mineral assemblages in pelitic gneisses (subunits 2s,c and u); (b) Distribution of diagnostic mineral assemblages in granitoid rocks (Unit 4); (c) Distribution of diagnostic mineral assemblages and textures in gabbroic rocks.*



and/or hornblende. Although the composition of opaque phases has yet to be determined, the formation of sphene suggests that ilmenite may be present in some of the granitoid rocks. The formation of sphene may result from a combination of the reaction:

Ilmenite + plagioclase ± hornblende → sphene + biotite + K-feldspar + biotite + quartz ± H_2O R5

METASEDIMENTARY GNEISS

Metasedimentary gneiss enclaves (subunit 2s) associated with K-feldspar megacrystic granite in the metagabbro unit of the White Bear Arm complex, contain sillimanite + garnet assemblages, and muscovite locally replaces biotite and sillimanite.

In the Gilbert River belt, metasedimentary pelitic gneiss is characterized by sillimanite + K-feldspar and melt assemblages. A garnet-rich, diatexitic phase is associated with the pelitic gneiss in many localities.

Metasedimentary gneiss in the Mealy Mountains terrane is characterized by sillimanite + garnet and K-feldspar assemblages. At some localities in the southeast corner, garnet is unstable and the breakdown is observed as two textural relationships: (i) symplectic intergrowths of biotite + sillimanite and quartz developed within embayed garnets in contact with K-feldspar, and (ii) up to 80 percent biotite + sillimanite pseudomorphs of subhedral garnet porphyroblasts. Both textures appear to result from the reaction:

Garnet + K-feldspar → sillimanite + biotite + quartz R6

One locality of migmatitic gneiss (subunits 2s/2z) in the northwest part of the region contains the assemblage cordierite + garnet + sillimanite + biotite and an opaque phase in the

melanosome. Cordierite that is not in contact with garnet, occurs as subhedral, 0.5 mm porphyroblasts that are partially to completely pseudomorphed by biotite and sillimanite and is mantled locally by quartz rims, suggesting the reaction (Newton, 1972):

Cordierite → biotite + sillimanite + K-feldspar + quartz + magnetite.....R7

Cordierite that is adjacent to garnet grains is partially pinitized and locally rimmed by quartz and biotite. Small (0.2 mm), anhedral, pinitized cordierite grains also occur as inclusions within garnet and as isolated grains within the leucosome.

An enclave of pelitic gneiss (subunit 2s) within amphibolitic gneiss (subunit 1a) in the northwest part of the region contains sillimanite + orthopyroxene + biotite in the melanosome. Anhedral, recrystallized orthopyroxene appears stable with sillimanite and biotite within thin (0.3-mm-wide) localized melanosome bands. Small, isolated orthopyroxene grains also occur within a quartz-rich leucosome. Reactions that generate orthopyroxene in pelitic gneiss are discussed by Newton (1972). The proximity of the cordierite-bearing assemblage discussed previously suggests that the sillimanite and orthopyroxene assemblage may represent the breakdown of cordierite via the reaction:

Cordierite → enstatite + sillimanite + quartz.....R8

Syenitic to quartz–syenitic rocks (subunit 4h) in the northwest corner of the map region contain recrystallized orthopyroxene ± clinopyroxene + hornblende assemblages. The development of hornblende as thin retrograde zones along pyroxene margins is suggestive of a granulite to upper amphibolite-facies transition. In other parts of this unit, polygonal orthopyroxene appears stable with hornblende with no evidence of retrogression.

A $^{40}Ar/^{39}Ar$ hornblende age of 980 ± 3 Ma determined from the same unit (approximately 10 km to the north) in the Paradise River region (van Nostrand, 1988) is interpreted as a post-Grenvillian cooling age and suggests that the rock was elevated above *ca.* 500°C at *ca.* 980 Ma.

RETROGRADE ASSEMBLAGES

Retrograde assemblages are locally developed in all units. However, the degree of alteration is sporadic and no regional pattern was observed.

Retrogression in metasedimentary gneiss is indicated by partial replacement of biotite and sillimanite by muscovite, by minor chlorite rims mantling garnet porphyroblasts and by partial replacement of biotite by chlorite and/or epidote.

Muscovite is present as pseudomorphs of fine-grained, fibrolitic sillimanite aggregates and as sericitic rims mantling prismatic sillimanite grains, indicating the reaction (Kerrick, 1972):

Sillimanite + K-feldspar + H_2O → muscovite + quartz.....R9

In granitoid rocks, biotite and hornblende are locally replaced by chlorite and epidote. Plagioclase and K-feldspar are commonly sericitized.

Hornblende-bearing assemblages in mafic rocks are locally retrogressed to biotite and chlorite. Metamorphic pyroxenes in mafic rocks are locally partially altered to hornblende.

DISCUSSION OF LABRADORIAN AND GRENVILLIAN EFFECTS

Metamorphic effects of the Labradorian and Grenvillian orogenies in the Alexis River study region can be distinguished to some extent on the basis of radiometric dating in the eastern Grenville Province. U–Pb dating on zircon, monazite and titanite (Schärer *et al.*, 1986; Schärer and Gower 1988), $^{40}Ar/^{39}Ar$ ages on hornblende and biotite (van Nostrand, 1988; Reynolds, 1989) and Rb–Sr whole-rock ages (Prevec *et al.*, 1990) have recorded variable Labradorian and Grenvillian metamorphic events in the Hawke River, Lake Melville and Mealy Mountains terranes.

Evidence of a high-grade Labradorian metamorphism (upper-amphibolite to granulite facies) and a moderate Grenvillian metamorphic event in the Hawke River terrane is supported by:

(i) 1650 to 1630 Ma U–Pb ages determined from titanites and monazites (Schärer and Gower, 1988) suggest an average age of 1647 Ma of closure in U–Pb titanite systems in the eastern Hawke River terrane, (ii) retention of Labradorian Rb–Sr whole-rock ages from the Sand Hill River area (Prevec *et al.*, 1990), (iii) mafic dykes from Earl Island retain a pre-Grenvillian paleomagnetic remanence (Murthy *et al.*, 1989b), (iv) primary, osumilite-bearing, contact metamorphic assemblages are preserved adjacent to the Sand Hill Big Pond gabbronorite (Arima and Gower, 1991), and (v) a 1241 ± 3 Ma $^{40}Ar/^{39}Ar$ plateau age from hornblende in the southern portion of Sandwich Bay suggests that temperatures during Grenvillian metamorphism were locally not sufficient to completely reset argon systems in hornblende (van Nostrand, 1988).

In the Mealy Mountains terrane, a strong Labradorian signature is suggested by 1650 to 1630 Ma monazite and titanite ages (Schärer and Gower, 1988). Emslie *et al.* (1984) argues that Grenvillian metamorphic effects were not high-grade (greenschist facies or lower) in the Mealy Mountains, and Reynolds (1989) reported pre-Grenvillian, 1250 to 1200 Ma $^{40}Ar/^{39}Ar$ ages from amphibolite dykes (Mealy dykes) in the Mealy Mountains and suggested that Grenvillian effects were limited to partial argon-loss in hornblende.

On this basis, high-grade mineral assemblages and much of the fabric in the Hawke River and Mealy Mountains terranes are interpreted to be Labradorian age.

In contrast, *ca.* 1030 Ma ages from monazite and titanite suggest that there was a strong Grenvillian metamorphic effect resulting in resetting of U–Pb systems in monazite and titanite in the Lake Melville terrane, which includes the Gilbert River belt (Schärer *et al.*, 1986). They interpret the *ca.* 1030 Ma ages in the Lake Melville terrane to result from Grenvillian anatexis. Thus, high-grade mineral assemblages in the Gilbert River belt are of probable Grenvillian age (*ca.* 1030 Ma). The difference in ages suggests that the faults separating the Mealy Mountains and Lake Melville terranes, and the Hawke River (includes the White Bear Arm complex) and Lake Melville terranes are deep-rooted structures, separating Grenvillian moderate-grade terranes (Mealy Mountains and Hawke River) and a Grenvillian high-grade terrane (Lake Melville).

Lower to middle amphibolite-facies retrograde assemblages in most units in the Alexis River region may represent two different periods of cooling. A 980 Ma $^{40}Ar/^{39}Ar$ hornblende age, reported north of the study area in the Mealy Mountains terrane is interpreted to date cooling through *ca.* 500°C, and may represent the time of Grenvillian retrogression of Labradorian assemblages. Alternatively, retrograde assemblages could be related to post-Labradorian cooling.

Grenvillian effects in the Hawke River terrane are indicated by (i) *ca.* 1030 Ma titanite ages (Schärer *et al.*, 1986) near major strike-slip and thrust faults, probably related to Grenvillian tectonism, and (ii) $^{40}Ar/^{39}Ar$ ages (van Nostrand, 1988), which suggest that thermal reheating resulted in partial argon-loss during Grenvillian metamorphism.

In the Lake Melville terrane, north of the study area, a $^{40}Ar/^{39}Ar$ hornblende age suggests cooling through 500°C at *ca.* 1020 Ma (van Nostrand, 1988). The age agrees with a post-Grenvillian retrogression of high-grade assemblages formed at *ca.* 1030 Ma. On this basis, retrograded mineral assemblages in the Gilbert River belt are interpreted to result from post-Grenvillian cooling.

In summary, high-grade mineral assemblages and much of the fabric in the Hawke River terrane (includes the White Bear Arm complex) and the Mealy Mountains terrane are interpreted to be Labradorian in age. Grenvillian effects or post-Labradorian cooling resulted in development of retrograde assemblages. In the Lake Melville terrane, high-grade mineral assemblages are interpreted to be Grenvillian in age, whereas retrograde assemblages resulted from post-Grenvillian cooling.

ECONOMIC GEOLOGY

The economic potential of the Alexis River region is indicated by:

(i) Less than 1 percent disseminated pyrite occurs within fault breccia and quartz veins associated with a northeast-trending fault in the northwestern part of the region (52°49'20" N, 57°12'40" W). Minor (< 1 percent) pyrite is also present within a post-Grenvillian fine-grained diabase dyke intruding foliated diorite along the Paradise River (52°48'59" N, 57°55'02" W).

(ii) Magnetite crystals, up to 6 cm in diameter, occur within coarse alkali-feldspar granite pegmatites, which intrude coarse gabbro intrusions along the Alexis River (52°39'45" N, 57°06'10" W).

(iii) Rare, anomalous radioactive total-count signals of 250 to 350 counts per second, above average background readings (40 to 60 counts per second), were determined from late coarse pegmatites and granites in the central part of the region and in the northern pegmatite field.

(iv) Rusty weathering zones associated with metasedimentary gneiss occur mostly in the southeastern corner, where the gneiss is intruded by K-feldspar megacrystic granite and a minor, late-stage garnetiferous syenogranite. Rusty zones are typically only 1 to 2 m wide and no evidence of mineralization was observed.

Gower *et al.* (1987) noted ilmenite and magnetite occurrences associated with the Alexis River anorthosite in the Port Hope Simpson region. Potential for occurrences of these minerals exists in the poorly exposed extension of the anorthosite in the Alexis River region.

In a correlation of metallogenic environments in the Baltic region with Laurentian analogues, Gower (1992) emphasized the similarities in geological histories between Baltica and Laurentia during the mid-Proterozoic and the potential for metallogenic occurrences in Labrador. Notable potential economic targets for the Grenville Province in eastern Labrador include:

(i) Sulphide mineralization associated with the pre- or syn-Labradorian metasedimentary gneisses of the Paradise metasedimentary gneiss belt that are correlated with pre-Gothian–Kongbergian temporal equivalents in Baltica.

(ii) Late- to posttectonic granitoid intrusions in southern Labrador are correlated with Mo and Au mineralized granites in the Sveconorwegian Province. Although no known examples in Labrador are comparable either to Mo or Au mineralization in the Sveconorwegian Province, Gower (1992) notes that 'it is not difficult to understand why mineralization might have escaped detection, since large areas of southernmost Labrador are poorly exposed and unmapped, even at 1:250 000

reconnaissance scale'. Late- to posttectonic granites in southern Labrador do however locally contain U mineralization and are generally enriched in large ion lithophile (LIL) elements.

Although the correlations made by Gower (1992) do not directly relate to rocks in Alexis River region, some generalizations can be made.

Presence of locally rusty weathering metasedimentary gneiss, in the southeast corner of the region, which although no mineralization was detected, are similar, both in composition and probably age to sulphide-bearing gneisses in the Paradise metasedimentary gneiss belt. Late, small-scale quartz veins associated with post- to syn-Grenvillian faults contain minor disseminated pyrite in the northeast part of the region. These may be correlative with late- to posttectonic Au- and Mo-bearing veins in the Sveconorwegian Province.

SUMMARY

Regional 1:100 000 scale mapping in the Alexis River map region has extended the known distribution of three lithostructural terranes of the Grenville Province in eastern Labrador. The White Bear Arm complex, the Gilbert River belt and the Mealy Mountains terrane have been distinguished on the basis of different lithological and structural associations. Boundaries of the terranes are marked by northwest-trending ductile-brittle faults, which connect with major crustal-scale tectonic boundaries defined by Gower *et al.* (1987) and Gower (1990). Metagabbroic and gabbronoritic rocks in the northeast are part of an extensive layered mafic intrusion (White Bear Arm complex), which is a major unit of the Hawke River terrane. South of this terrane, northwest-trending units of variably deformed granitoid rocks and metasedimentary gneiss comprise a portion of the Gilbert River belt, a zone of intense deformation defined by Gower *et al.* (1987) and refined by Hanmer and Scott (1990). The Mealy Mountains terrane to the south is separated from the Gilbert River belt along a northwest-trending fault, which exhibits both ductile and brittle features along its length. The terrane is dominated by variably deformed granitoid rocks and orthogneiss, metasedimentary gneiss and a composite monzonite to syenite pluton (Upper Paradise River pluton).

Deformation in the region is strongest in the eastern part of the Gilbert River belt, which is characterized by a well-developed gneissosity in most units. The fabric intensity decreases to a moderate to strongly developed foliation in the western portion of the belt. In the Mealy Mountains terrane, the deformation is characterized by a northwest- to southwest-trending, moderately to strongly developed foliation.

Metamorphic grade ranges from upper amphibolite to locally granulite facies in all three terranes. Retrogression to lower amphibolite assemblages is developed to varying degrees in most units. No significant variation in metamorphic grade is evident between the terranes, as mineral assemblages in granitoid rocks, metasedimentary gneiss and mafic rocks are similar throughout the map region. (Quantitative metamorphic P–T estimates from assemblages in metasedimentary gneiss and mafic rocks are pending.)

High-grade assemblages and much of the fabric in the Hawke River terrane (White Bear Arm complex) and the Mealy Mountains terrane are interpreted to be pre-Grenvillian (Labradorian) in age. Retrograde assemblages may represent either post-Labradorian cooling or Grenvillian metamorphism and subsequent cooling.

High-grade assemblages and much of the fabric in the Lake Melville terrane are interpreted to be Grenvillian in age.

Economic potential of the region is indicated by minor disseminated pyrite associated with post-Grenvillian dykes and faults, and local anomalous radioactivity (total counts) measurements obtained from late granite pegmatites and coarse granites.

ACKNOWLEDGMENTS

This project is funded by the Canada–Newfoundland Cooperation Agreement on Mineral Development (1990-1994); the project is carried by the Geological Survey Branch, Department of Mines and Energy, Government of Newfoundland and Labrador.

Thanks are extended to senior field assistants Don Dunphy and Darrell Eddy and junior assistants Joe Anderson, Mark Blake and Bob Patey who were willing and able throughout the field season. Canadian Helicopters, through pilot Sean Tucker, provided excellent service. Labrador Airways, through pilot Malcolm Pilgrim, is thanked for service. Dr. Charles Gower is thanked for his mapping contribution and field insights during the final week and for discussion throughout the writing of this report. Wayne Tuttle and Richard White provided efficient expediting services out of Goose Bay. Drs' Richard Wardle, Charles Gower and John Tuach reviewed and improved the manuscript.

REFERENCES

Arima, M. and Gower, C.
1991: Petrological and geochemical characteristics of osumilite-bearing granulites in the eastern Grenville Province, eastern Labrador, Canada. Journal of Geology, Volume 32, pages 29-61.

Eade, K.E.
1962: Geology, Battle Harbour–Cartwright, Labrador. Geological Survey of Canada, Map 22-1962.

Emslie, R.F.
1976: Mealy Mountains Complex, Grenville Province, southern Labrador. *In* Report of Activities, Part A. Geological Survey of Canada, Paper 76-1A, pages 165-170.

Emslie, R.F., Loveridge, W.D. and Stevens, R.D.
1984: The Mealy dykes, Labrador: petrology, age and tectonic significance. Canadian Journal of Earth Sciences, Volume 21, pages 437-446.

Gardner, P.M. and Robins, B.
1974: The olivine–plagioclase reaction: geological evidence from the Seiland petrographic province, northern Norway. Contributions to Mineralogy and Petrology, Volume 44, pages 149-156.

Geological Survey of Canada
1974a: Aeromagnetic maps 13A/11, 12, 13, 14, Newfoundland. Scale 1:63 360. Geological Survey of Canada, Maps 5979G, 5978G, 5987G and 5986G.

1974b: Aeromagnetic map 13A and 13D. Battle Harbour, Newfoundland. Scale 1:250 000. Geological Survey of Canada. Map 7377G.

Gower, C.F.
1990: Mid-Proterozoic evolution of the eastern Grenville Province, Canada. Geologiska Föreningens i Stockholm Förhandlingar, Volume 112, part 2, pages 127-139.

1992: The relevance of Baltic Shield metallogeny to mineral exploration in Labrador. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 92-1, pages 331-366.

Gower, C.F., Erdmer, P. and Wardle, R.J.
1986c: The Double Mer Formation and the Lake Melville rift system, eastern Labrador. Canadian Journal of Earth Sciences, Volume 23, pages 359-386.

Gower, C.F., Finn, G., Gillespie, R.T., Noel, N. and Owen, V.
1983: Sandwich Bay 1:100 000 map sheet. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 83-45.

Gower C.F., Neuland, S., Newman, M. and Smythe, J.
1987: Geology of the Port Hope Simpson map region, Grenville Province, eastern Labrador. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 87-1, pages 183-199.

1988b: Port Hope Simpson 1:100 000 map sheet. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 88-88.

Gower, C.F., Noel, N. and van Nostrand, T.
1985: Geology of the Paradise River map region, Grenville Province, eastern Labrador. *In* Current Research, Part B. Geological Survey of Canada, Paper 85-1B, pages 547-560.

1986a: Paradise River 1:100 000 map sheet. Newfoundland Department of Mines and Energy, Mineral Development Division. Map 86-73.

Gower C.F., van Nostrand, T., McRoberts, G., Crisby, L. and Prevec, S.
1986b: Geology of the Sandhill River map region, Grenville Province, eastern Labrador. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 86-1, pages 101-111.

Gower C.F., van Nostrand, T. and Smythe, J.
1988a: Geology of the St. Lewis River map region, Grenville Province, eastern Labrador. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 88-1, pages 59-73.

Greene, B.A.
1972: Geological map of Labrador (1:1 000 000 scale); Mineral Resources Division, Department of Mines and Energy, Agriculture and Resources, Province of Newfoundland and Labrador.

1974: An outline of the geology of Labrador. Information Circular No. 15. Mineral Development Division, Department of Mines and Energy, Province of Newfoundland, 64 pages.

Griffin, W.L. and Heier, K.S.
1973: Petrological implications of some corona structures. Lithos, Volume 6, pages 315-335.

Hanmer, S. and Scott, D.
1990: Structural observations in the Gilbert River belt, Grenville Province southeastern Labrador. *In* Current Research, Part C. Geological Survey of Canada, Paper 90-1C, pages 1-11.

Jenkins, D.M. and Newton, R.C.
1979: Experimental determination of the spinel peridotite to garnet peridotite inversion at 900°C and 1000°C in the system CaO-MgO-Al_2O_3-SiO_2 and at 900°C with natural garnet and olivine. Contributions to Mineralogy and Petrology, Volume 68, pages 407-419.

Kerrick, D.M.
1972: Experimental determination of muscovite + quartz stability with P H_20 × P total. American Journal of Science, Volume 272, pages 946-958.

Murthy, G., Gower, C., Tubrett, M. and Patzold, R.
1989a: Paleomagnetism and geochemistry of Carboniferous Sandwich Bay dykes from coastal Labrador. Canadian Journal of Earth Sciences, Volume 26, pages 2278-2291.

1989b: Paleomagnetism of pre-Grenvillian mafic intrusions from the Grenville Province, southeast Labrador. Canadian Journal of Earth Sciences, Volume 26, pages 2541-2555.

Newton, R.C.
1972: An experimental determination of the high pressure stability limits of magnesian cordierite under wet and dry conditions. Journal of Geology, Volume 80, pages 398-420.

O'Neill, H.
1981: The transition between spinel lherzolite and garnet lherzolite, and its use as a geobarometer. Contributions to Mineralogy and Petrology, Volume 77, pages 185-194.

Prevec, S.A.
1987: The petrology, geochronology and geochemistry of the White Bear Arm complex and associated units, Grenville Province, eastern Labrador. M.Sc. thesis, McMaster University, Hamilton, Ontario, 155 pages.

Prevec, S.A., McNutt, R.H. and Dickin, A.P.
1990: Sr and Nd isotopic and petrological evidence of the age and origin of the White Bear Arm complex and associated units from the Grenville Province in eastern Labrador. *In* Mid-Proterozoic Laurentia-Baltica. *Edited by* C.F. Gower, T. Rivers and B. Ryan. Geological Association of Canada, Special Paper 38, pages 65-78.

Reynolds, P.H.
1989: $^{40}Ar/^{39}Ar$ dating of the Mealy dykes of Labrador: paleomagnetic implications. Canadian Journal of Earth Sciences, Volume 26, pages 1567-1573.

Schärer, U. and Gower, C.
1988: Crustal evolution in eastern Labrador, constraints from precise U-Pb ages. Precambrian Research, Volume 38, pages 405-421.

Schärer, U., Krogh, T. and Gower, C.
1986: Age and evolution of the Grenville Province in eastern Labrador from U-Pb systematics in accessory minerals. Contributions to Mineralogy and Petrology, Volume 94, pages 438-451.

Streckheisen, A.
1976: To each plutonic rock its proper name. Earth Science Reviews, Volume 12, pages 1-33.

van Nostrand, T.
1988: Geothermometry–geobarometry and $^{40}Ar/^{39}Ar$ Incremental Release Dating in the Sandwich Bay area, Grenville Province, eastern Labrador. Unpublished M.Sc. thesis, Memorial University of Newfoundland, 203 pages.

Wells, P.R.A.
1977: Pyroxene thermometry in simple and complex systems. Contributions to Mineralogy and Petrology, Volume 62, pages 129-139.

Wones, D.R. and Eugster, H.P.
1965: Stability of biotite: experiment, theory and application. American Mineralogist, Volume 50, pages 1224-1272.

MAPS NOT FILMED

CARTES NON REPRODUITES

micromedia
a division of IHS Canada

20 Victoria Street
Toronto, Ontario M5C 2N8
Tel.: (416) 362-5211
Toll Free: 1-800-387-2689
Fax: (416) 362-6161
Email: info@micromedia.on.ca